DOCUMENT RESUME

ED 224 723 SE 039 855

AUTHOR	Bandhu, Desh, Ed.
TITLE	Environmental Management.
INSTITUTION	Indian Environmental Society, New Delhi.
PUB DATE	81
NOTE	132p.; Selected papers from a Seminar held at the Indian National Science Academy (New Delhi, India, June 5-7, 1980).
AVAILABLE FROM	Indian Environmental Society, 8, Darya Ganj, New Delhi-110002, Indian (Rupees $50.00, U.S. $10.00).
PUB TYPE	Collected Works - Conference Proceedings (021) -- Reports - General (140)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Coal; *Environmental Education; Environmental Influences; Environmental Research; Environmental Standards; Foreign Countries; Forestry; *Mining; Oceanography; *Physical Environment; Policy Formation; *Pollution; Power Technology; *Program Descriptions; Socioeconomic Influences; Water Resources
IDENTIFIERS	*Environmental Management; *India; Irrigation

ABSTRACT

The Indian Environmental Society, in association with the International Programme on Environmental Management Education, organized two seminars on World Environment Day and Environmental Impact Assessment during June 1980. A large number of papers on various aspects of environmental management were presented during the seminars. The papers addressed a wide range of issues including the environmental situations in India, social forestry, environmental impact assessment, problems of mining, and other various related problems. Titles of these selected papers include: "Environmental Impact Assessment as a Tool for Environmental Quality Management"; "Environmental Situation in India"; "Some Socio-Economic Issues in Social Forestry"; "Population, Employment and Environment"; "Marine and Coastal Environmental Management"; "Environmental Problems due to Mining in the Jharia Coalfield"; "Irrigation and the Environment"; and "The Silent Valley Hydroelectric Project -- a Draft Environmental Impact Assessment." The inaugural address, The address by the chief guest, and a list of participants are included. (Author/JN)

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ED224723

ENVIRONMENTAL MANAGEMENT

(Selected Papers at Seminar held at Indian National Science Academy, New Delhi during June 5-7, 1980)

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INDIAN ENVIRONMENTAL SOCIETY

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This Publication can be obtained from:
Indian Environmental Society
8, Darya Ganj, New Delhi-110002 (India)

Price : Rs. 50.00
US $ 10.00

Distributors in India:
NATRAJ PUBLISHERS
17, Rajpur Road,
Dehradun (U.P.)

© INDIAN ENVIRONMENTAL SOCIETY

First Published 1981

Printed by Satish Composing Agency at Times Press, 910 Jatwara Street, Darya Ganj, New Delhi-110002.

CONTENTS

		Pages
Preface		vii
List of Contributors		xi
1	Inaugural Address *B.P. Pal*	1
2	Address of Chief Guest *C. Suriyakumaran*	7
3	Environmental Impact Assessment as a Tool for Environmental Quality Management *M.G. Royston*	15
4	Environmental Situation in India *Desh Bandhu*	29
5	Some Socio-Economic Issues in Social Forestry *Jeff Romm*	45
6	Population, Employment and Environment *S. Venkatesh*	55

C[illegible] 4

		Pages
7	Marine and Coastal Environment Management *R. Sen Gupta*	67
8	Environmental Problems due to Mining in the Jharia Coalfield *S.P. Banerjee*	81
9	Irrigation and the Environment *K.K. Khatu, P.M. Gujarathi, A.K. Tamang and S.N. Morankar*	97
10	The Silent Valley Hydroelectric Project-A draft Environmental Impact Assessment *M.K. Prasad and M. Sivasankaran*	109
11	List of Participants	121

PREFACE

THERE HAS BEEN significant advances in the last decade in our understanding of the integrated relationship between Environment and development. The concept has been advanced that environment should be viewed as a stock of physical and social resources available at a given time for the satisfaction of human needs, and development as a process pursued by all societies with the aim of increasing human welfare.

Environmental Management is not yet a full-fledged discipline in formal curriculum of studies. In developing countries, it is viewed as being irrelevant and counter-productive. This concept is changing fast. The developing countries has realized the importance of the Environmenal Management Policies.

The Six Five Year Plan (1980-85), Framework Document of Govt. of India, in the Section on Ecology and Environment include "It is imperative that we carefully husband our renewable resources of soil, water, plant and animal life to sustain our economic development. Over-exploitation of these is reflected in soil erosin, siltation, floods, and rapid destruction of our forest, floral and wildlife resources. The depletion of these resources often tends to be irreversible and since the bulk of our population depends on these natural resources to meet their basic needs, particularly of fuel, fodder and housing material, it has meant a deterioration in their quality of life".

The Enviromental Management Policies advocate for the better results from development projects if they are environmentally sound. In the last five years, environmental experts have been involved increasingly in project planning, and consideration of the environmental cultural, and social impacts and suitability have become gradually incorporated in planning process.

The Committee for Recommending Legislative Measures and Administrative Machinery For Environmental Protection, has recommended the need for the training of planners and administrators on environmental management. At higher level, there must be 'environmental orientation' in order to expose the decision makers to the systems approach that should underpin all planning and execution of national building activities. There should be expertise in all the ministries and Departments to assess the environmental impact of projects.

The Indian Environmental Society in association with the International Programme on Environmental Management Education (CEI/UNEP) organised two seminars on World Environment Day and Environment Impact Assessment during June 5-7, 1980 at the Indian National Science Academy, New Delhi. The seminars were attended by a large number of delegates from different organisations including the top level participation of United Nations Environment Programme. Dr. C. Suriyakumaran, Director, Regional Office of UNEP for Asia and Pacific was the Chief Guest at the Seminars. Mr. George Muhoho, Chief of the Information Division of UNEP, was the special guest at the World Environment Day seminar (the report of the World Environment Day seminar is printed separately).

A large number of papers on various aspects of Environmental Management were presented during the seminars. The papers include wide range of issues including the Environmental situations in India, Social Forestry, Environmental Impact Assessment, the problems of mining and other various related problems. It has therefore been decided to publish the selected papers in a book form, for wider circulation. I am sure this publication will be of considerable interest and profit to all those who are concerned on Environmental Management.

I would like to thanks the International Programme on Environmental Management Education (CEI/UNEP), Department of Science and Technology, for their financial assistance,

which made the seminars and this publication a success. I am thankful to Professor B.P. Pal, F.R.S. Dr. C. Suriyakumaran, Mr. George Muhoho, Dr. M.G. Royston, Prof. R. Misra and Dr. N.L. Ramanathan for their addresses during the seminars. The thanks are also due to Indian National Science Academy, New Delhi for their help in providing facilities to hold the seminar. The thanks are also due to the Organising Committee of the seminars and to the contributors of this volume.

NEW DELHI
MARCH 10, 1981

DESH BANDHU

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1

Inaugural Address

B.P. Pal

I AM HAPPY to be here on this occasion when we are once again observing World Environment Day. I am glad to see so many distinguished persons who are interested in various aspects of the environment and the problems which confront us in this field. There is now a much greater awareness of the need for conservation of the earth's resources, and, only about three months ago this country participated in the launch of the World Conservation Strategy. I do not need to tell this audience about the tremendous problems that have arisen because of the great increase in the human population and its demands upon this planet's finite resources. I would like to quote, however, a brief statement on the 'environment crisis' from a UNESCO publication which reads as follows:

> "Imperfect understanding of the natural systems and mechanisms which make possible the maintenance of life on earth; disregard of the unintentional effects of technology, in particular the various forms of pollution; poor management of the soil, forests and water; unbridled consumption of fossil fuels; uncontrolled urbanization; the relegation of the rural population to a marginal position; and the crushing of traditional cultures—these are the most obvious and most frequent disadvantages of the change that is taking place in the relations between man and his environment."

Against this background we have to consider what it is that we can do to ensure that while making material progress we do not overstep the limits, and that we work within the limits of what has been referred to as "sustainable development" the World Conservation Strategy document. Since the problems are so vast and the action required so urgent, and in so many fields, I would only like on this occasion to draw your attention to a few matters of vital concern. The first is the fact that with so many individuals, and so many groups and societies, expressing themselves, sometimes in very strong terms, there is a certain amount of confusion in the public mind as to what are the real priorities in the endeavour to protect and conserve as much of our natural heritage as possible, without at the same time, impeding the processes of development which are necessary to maintain a decent quality of life for the people. One has to take an overall view, balancing the various factors, identifying what is the most important and giving prior attention to it.

The pollution of the air, the waters of the earth and the oceans and poisoning of even the soil itself, is causing dreadful consequences in some areas. There is, no doubt, need for immediate and strong action to ensure that industries and enterprises, whether public or private, which can cause pollution are sited properly and that measures for prevention and reduction of pollution are incorporated at the time of setting up of such projects as it is much cheaper to do so at that stage rather than later. The problems of pollution and disposal of dangerous waste materials have occupied a great deal of attention in developed countries and are beginning to receive similar attention in developing countries also. But this only one part though an important one of the entire problem of conservation.

I whould like to draw special attention to the erosion of one of the most basic of resources, namely, the soil because it has a direct connection with man's food supplies. Human beings depend for a large proportion of their food on plants like the cereals, the grain legumes, edible oilseeds, tubers and roots and fruits and vegetables and some of them also con-

sume meat and fish. But neither men nor animals can manufacture their own food and either they feed on plants directly or, on other animals which in turn feed on plants. It is only plants which can use the energy of sunlight to manufacture their own food from simple elements which they obtain from the air and the soil. Here it must be pointed out that the vast majority of plants grow in the soil. This is why, when discussing environmental problems, we must give the topmost priority to conservation of the soil on which all our agricultural plants, industrial crops, medicinal and other plants, etc., depend. Large areas of land are being subjected to serious erosion by wind and water, leading in some cases to desert conditions. Once we lose the fertile topsoil which has been formed over long periods of time, what shall we do? How will we raise the food, the fodder, the fuel and the other requirements of the human population which is increasing at a frightening rate? We have to see that agricultural practices are consonant with ecological wisdom, that over-grazing by domestic animals is obviated; city planners and those in charge of large projects will have to be told that precious land suitable for agriculture and forestry must not be encroached upon.

Another very important matter to which I would like to draw special attention is the need for preserving our living resources. While World Wildlife Fund and other agencies have done a splendid job in their endeavour to see that certain animals and birds which are endangered are given suitable protection and are not allowed to become extinct. But the importance of preserving plant species and also microorganisms has tended to be overlooked. I am not referring only to the beautiful orchids and such striking plants. I am referring the great groups of plants which form the backbone of agriculture and horticulture, including not only the food crops but the industrial crops, and other economic plants which give us drugs and chemicals and so on. It is true that in the case of some major crop plants, endeavour is made by scientific departments and research centres to preserve collections of germplasm and we have, no doubt, made considerable advances in improving the crop plants.

But every now and then, even in countries where agriculture is practised on a sophisticated level, a new pest or a disease may arise which can only be controlled by locating a source of genetic resistance and incorporating this into the commercial varieties. Quite often this source of resistance is found in old varieties which are being increasingy ousted by the modern high-yielding strains, or in wild or semi-wild relations of cultivated plants. It is most important, therefore, that areas of rich genetic diversity and ecological importance are preserved in the form of Biosphere Reserves, Gene Sanctuaries, etc., where the intricate web of life can continue, in an evolving process.

Yet another areas to which I must refer specially is that of forests and forestry. The economic importance of forests is well known. But their crucial ecological role is not so well understood. This is the role they play in influencing the wind, the temperature, the humidity, soil and water. There has been a tendency to regard forests only as resousces for exploitation. Their protective role has to be recognised and it is necessary to do reforestation on a large scale. There has to be a complete re-orientation of the forest policy which will recognise the protective role of forests and the need for social forestry to provide for the needs of local populations including the tribal people. The appalling destruction of forests all over the world and in this country, in recent years, has led to serious consequences which are very evident. India has had magnificent forests in the past but many are disappearing inculding the tropical rain forests which are specially rich in plant species.

I have referred to a few basic matters which affect our life support systems. If we go on losing the soil, and the plant and other living resources at the rate at which this is happening at present, what will be the situation in a few years when the human population will have increased even more? It is most important, therefore, that there should be overall planning and coordination to ensure that while the multiplicity of problems receive the attention should be focussed on basic aspects such as those I have mentioned in an

integrated balanced manner. For doing this, scientifically sound environmental impact assessment is a necessity: I am glad therefore that this subject is also going to receive special attention in the Seminar that follows.

I thank you for giving me the opportunity to be present here today and I wish your delibrations great success. I now have pleasure in inaugurating the Seminars.

2

Address of Chief Guest

C. Sariyakumaran

Thank you Mr. Chairman,

I HAVE to apologise for the condition of my throat but apparently, in the midst of this environmental crisis in energy,* this rough timbre partially compensates for the inability otherwise to have been heard. Sir, coming at the end of a list of speakers and with the inaugural statement yet to be made by a distinguished citizen of this country, I do not think even the accolade of being called the Chief Guest is any compensation; and therefore, at this time and at this juncture, I want to spare myself and you by being briefer than I intended to be.

For me officially this is of course a special occasion. As somebody else said earlier, I have tried to be in various places during various years on Environment Day and it has been my privilege to be here in Delhi in this year 1980, to join with you in the observance of the Environment Day. But the Environment Day is not something limited; it is not something that is strictured in terms either of space or of time. It is not something—I hope you will pardon me if I am quite frank with you because some of the limitations that we suffer

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From recording of speech as delivered.

*A complete power cut that occurred during most of the opening session.

from we are all generally guilty of—for us here, as a group seated here. It is not something for Delhi, it is not something for India alone. It is something for the whole earth and more particularly it is perhaps not something so much for the cities, although it is a problem in the cities, as the so-called environmental pollution problem. It is much more—and here I wish to echo what was I think behind Prof. Ghanguli's obsesvations on fuel wood—it is something for the countryside and for the ordinary people of the world.

On the second dimension, of time, I think it is important to remember that Environment Day is not just Today. Everyday is Environment Day and I do not say this as a slogan, simply because I have an official function to perform in my Agency. Everyday is Environment Day because, everyday, we have to live. If there is a relationship between man and his resources, whatever these resources are, whether it is a non-existent meal to a poor family or whether it is a sumptuous fair for some elite, we are living everyday; and it is this relationship between us and our resources which is the environment relationship. I think the purpose of observing Environment Day is in order to be able to highlight some of the contradictions that we have and these contradictions are very much outside this meeting room; to try to see how much we have done for ourselves as a people, to resolve these contradictions and to see what more we may perhaps need to do. I think it is an occasion to sharpen our perceptions, to make some resolve, not in the sense of passing a resolution. You know there was a distinguished foreign minister of a country who went to the United Nations for the first time, came back and told his countrymen 'You know there is something I discovered in a United Nations. We have been used normally when there is a problem to find a solution, but in the United Nations when there is a problem they do not find a solution, they find resolution!' Of course I am the first to defend the United Nations, I can choose another forum to do that; but I do not think it is enough for us, in observing Environment Day, to be able to derive self-satisfaction, shall we say, from an observance of this type alone. I think it is much more important to be able to go deeper into

a stock-taking, a stock-taking of what has been, and an assessment of what we have to do.

Since I have to be brief, let me just give you one example. Prof. Guanguli, I think, mentioned the scale of need of fire wood resources, a growth in terms of total fire wood needs if also there is a utilisation of fire wood in substitution for dung. Whatever it is, do we realise, for instance, while we feel with a sense of self-satisfaction that we are observing Environment Day, that in the concept of poverty as the greatest environmental degradation, as the greatest source of pollution—even more than ill-health; what is ill-health except half of that ill-health being derived from poverty in most of our countries—in order to solve this, what we shall be needing is, not a broom to clean the environment, but the use of twice, three times, four times the amount of resources that we are using in our developing countries than we have so far? Where are we going to find these resources? I would like to put it to you as environmentalists, to come out into the world and to face the challenge of finding an answer to this questions: 'Where shall we find three times or four times the resources that we are able to muster today in India, or Bangladesh, or Sri Lanka, or Pakistan, or Iran, or elsewhere? Where are we going to find this? And I put it to you also, if we do not find these resources we will never solve the environmental problem. I am not talking of the economic crisis. We have an energy crisis we say. There is no such thing as the energy crisis. I have said this on another occasion recently. W e never had; we will never have an energy crisis. What we are having is a crisis in the failure to apply technologies to the development of alternative energy resources, primarily renewable sources of energy—a whole spectrum of solar, wind, biogas, biomass, geothermal, and what have you. It is not only coal.

So my dear friends, I promised not to take too much time, but I do hope that this illustrative example, this example that I tried to give you, gives some substance to the concern that I have been trying to convey to you. It is something that I have done wherever I have had occasion to go. I

want, however, also to say here and now, as somebody who has observed the world scene, in particular the regional scene in the Pacific and in Asia, that as between 1973 and today the countries of this region have made remarkable progress at governmental level, at peoples level, at NGOs level, in their perceptions and in giving expression to their perceptions in policies, in law, in administration, and in patterns of resource use. They have established organisations which are increasingly meaningful; administrative systems which are increasingly relevant; bodies of legislation which are switching over from concepts of pollution as a 'protectionist' concept, to pollution as a 'productionist' concept; because one of the fundamental things that we have realised is that in the coalescence of environment and economics there is a forward movement that is taking place which we have to assist as environmentalists. And the forward movement is this. While the environmentalists are moving slowly, too slowly I think, but slowly, from the concept of environment as pollution to the concept of environment as resource management; the economists are moving today from the concept of development as resource use, to the concept of development as sustained resource use. And the moment you have these two, Sir, you have the beginnings of a harmonisation of environment and development. If you do not have this you will never solve your environmental problems and you will never be able to achieve the target that I have mentioned to you of the absolute need for our countries here to use twice, three times, four times or five times the resources for the poor people of the land, in order to solve the enviromental problem.

As Regional Director, I want to take note of two things before I conclude. Sir, we are here at a meeting organised by the Indian Environmental Society. I want to flag for you something which probably has not been said, that for the first time in Asia and perhaps for the first time in other regions, an Asian Environmental Society was formed last year. It began with a meeting in Colombo, followed up with a meeting in Tokyo and an Asian Environmental Society has been formed with a president, who is from Japan, and a secretary-

general who is this modest gentleman, Dr. Desh Bandhu; and that is probably the reason why he did not tell you this. I think this is something of a progress report which we should take note of. I would invite anybody who can help to really help, in two ways. One is, in each of the levels below the apex—and in India the apex is so far away, in India it is twenty-two states—it is essential for the apex NGO to have a network of all other NGOs. There is no monopoly of wisdom in the apex NGO. I hope you do not mind my saying that. It is the first homework that has to be done. The second is, please go out through the NGO movement into the factory, into the farm, into the people, to the young and the old, through movements on waste reclamation, on soil degradation, on village coordinated communal organisation where there is a composite concept of resource use at village level. You will see for yourself the genius that is there among the people and the people will be grateful for this type of assistance because historically, Sir, we, the bureaucrats have been guilty. We have cut up the village into a sociologist, an environmentalist, an economist, an engineer and what have you. And the bureacurats go down from Colombo, or Delhi, or Islamabad, or whatever and ask this villager to do all sorts of things in the name of various 'disciplines' which are the new substitutes for the gods that he worshipped in the old days. He does not understand; what he understands is a holistic approach to these—he lives in a house which is a human settlement; he uses the land and the water around him which is his environment; he puts them together in a process which he calls development; and this is what he understands.

So, I would commend this as an initiative and as a necessary initiative to the NGOs and I am addressing Dr. Desh Bandhu here as the Secretary-General of the Asian Environmental Society, not the Indian one now, and I would seek every support to him in this cause.

The second thing I wanted to say is, there was reference to the Mediterranean. We are all proud of this in UNEP but I think it is time that we talked about ourselves. We have

this difficulty sometimes. This is only the beginning, but because the Mediterranean is mentioned I think we should mention this. In March in Bangalore, ten countries which compose what is called South Asia, as disparate as you might find—and I want to be quite open—in any part of the world, with a history of 5,000 years of not agreeing with each other, from Iran to Burma and down to Sri Lanka and Maldives, agreed to set up an association of nations for cooperation in environment. And more, they agreed to identify a headquarters for this association. It is not a UNEP maintained institution. The headquarters was decided to be in Sri Lanka. They agreed also to assume responsibility for significant subject areas like Himalayan ecosystems, coastal areas, environment and development, energy as far as environment is concerned, each country assuming responsibility, not simply for itself but for the whole sub-region. So, Sir, we have an initiative and I think on this day, on Environment Day in 1980 at the beginning of this new decade, to me a cause of deepest satisfaction as an international is the potential that has been identified now—I call it potential because we have a lot of hard work to do—in the setting up of the South Asia Cooperative Environment Programme; and I entreat everyone of you to give it tender care and support. It is very easy, it you want to look for areas of dis-agreement in this world, it is the easiest thing in the world. We have to look for areas of agreement and when we find areas of agreement let us work through them and with them, and round them; and this is what we have done.

Sir, I know I have taken a little long but on this occasion I am tempted to quote as a concluding epilogue—not at length but just in one minute or two minutes—from an environmentalist of hundred and twenty-five years ago in America, a Red Indian Chief, who was asked by the Great White Chief in Washington to sell his land. And what he wrote back to the Great White Chief in Washington, that is the president of the United States, is in the archives in Washington and it has been described sometimes as perhaps the most touching statement on the environment ever made. I

want just to quote to you, Sir, a few lines on this and I quote:

> "The Great Chief in Washington sends word that he wishes to buy our land. How can you buy or sell the sky, the warmth of the land? The idea is strange to us. If we do not own the freshness of the air and the sparkle of the water, how can you buy them? So, when the Great Chief in Washington sends word that he wishes to buy our land, he asks much of us. But we will consider your offer to buy our land; it will not be easy, for this land is sacred to us. The rivers are our brothers; they quench our thirst. The rivers carry our canoes and feed our children. If we sell you our land, you must remember and teach your childern that the rivers are our brothers and yours. And you must henceforth give the rivers the kindness you gave any brother.
>
> But if we sell you our land, you must remember that the air is precious to us. That the air shares its spirit with all the life it supports. The wind that gave our grandfather his first breath also receives his lost sigh. And the wind must also give our children the spirit of life. Teach your children what we have taught our children; that the earth is our mother, whatever befalls the earth befalls the sons of the earth. If men spit upon the ground they spit upon themselves. This we know. The earth does not belong to man, man belongs to the earth. This we know. All things are connected like the blood which unites one family. All things are connected. Whatever befalls the earth befalls the sons of the earth. Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself.
>
> When the last Red Man has vanished from this earth and his memory is only the shadow of a cloud moving across the prairie these shores and forests will still hold the spirits of my people. For they love this earth as the new born loves its mother's heartbeat. So, if we sell our land,

love it as we have loved it. Care for it as we have cared for it. Hold in your mind the memory of the land as it is when you take it and with all your strength, with all your mind, with all your heart, preserve it for your children and love it, as God loves us all."

Thank you.

3

Environmental Impact Assessment as a Tool for Environmental Quality Management

M.G. Royston

IF ENVIRONMENTAL quality is to be assured, measures must be taken *before* the damage occurs, not after. The environmental dimension must be built into all policies, plans, programmes, projects and decisions. By so doing, not only the ecological success will be ensured, but also economic success, since prevention is not only *better* than cure, it is in many cases also *cheaper*.

Pollution can be prevented by taking adequate pollution control measures. But what measures are adequate—particularly for large or potentially hazardous projects in sensitive or fragile environments? What is needed is to set standards so or take account of the impact of that pollution on the specific local environment.

Impacts can be mitigated by the correct location of the project, placing it near similar projects, remote from sensitive populations and in such a way that the absorption and dispersion powers are a maximum. Careful zoning and land-use planning can help here, but since it does not take into account the specific nature of a future project, it cannot do more than give general guidance for location. What is needed is to assess the impact of the project on the specific environ-

ment concerned, and design the project, and locate it, accordingly.

	Pollution Control	*LUP*	*EIA*
Site Specificity	Specific	Non-Specific	Specific
Target Specificity	Non-Specific	Specific	Non-Specific
Time-Frame	Past	Present	Future
Planning Focus	Technology + Economics	Physical Resources	Human + Social Values
Value	Curative	Frame-Work	Preventative

The real objectives of environmental quality management are to focus specifically on those environmental areas which should be preserved or enhanced for the use of this and future generations. Hence it is necessary to consider specific projects and their specific environment. It becomes necessary to undertake a predictive exercise of potential impact, and since the ultimate objective is the quality of the human environment, the test of significance of any impact is against a background of human and social values. Above all, what is required is a preventative tool for environmental quality management. What is needed is a means of assessing the future impact which present decisions will have on the environment. It is exactly this confusingly named technique of Environmental Impact Assessment which, as can be seen in Table 1, completes and complements the more traditional instruments of pollution control and land use planning.

Environmental Impact Assessment (EIA) has by now been introduced into a number of countries as a formalized part of the project planning and licensing process. Sweden had a system based on the old water Courts, even before the USA introduced EIA with NEPA on the 1st January, 1970. The Philippines, Australia, New Zealand, Germany, France and Canada all have formalized procedure of one kind or another. The UK planning procedures and public hearing system is an informal EIA, as anyone could see who consults the proceedings of the hearings for the third London Airport, or the Windscale enquiry. The EEC is preparing guidelines for the 'Nine Ten' for harmonizing and formalizing EIA. In the centrally planned economies there is implicit consideration of environmental factors in economic planning.

However, despite all this experience, there is generalized dissatisfaction with most implicit systems because of lack of objectivity and insufficient 'crossefertilization' of different disciplines. There is also dissatisfaction with the informal systems since they lack vigour, and permit to much emotional swaying of the results. But there is equal dissatisfaction with the formalized systems. Sweden is revising hers to make it more comprehensive, Canada is moving to greater focus on social impacts, New Zealand has found her system unable to cope with major public issues, the USA has radically streamlined it's EIA procedures to bring significant impacts into sharper focus and to avoid project proponents hiding under mountains of paper. It can now be ssen that a number of specific questions should have been asked before introducing any EIA procedure. For example:

What is the purpose of the EIA? Is it to kill unsuitable projects or to help design better ones?

What size of projects should be studied? Large projects? Public and private projects? Medium sized projects? All projects? Depending on this answer, the number of projects being submitted to EIA in any year could range from zero to hundreds of thousands.

What is the environment which is being considered? The physical or the social? And if only the physical, how can you say how important it is?

Who represents these social valves? Experts? Advocates? The public? And if so in what form?

How may stages of assessment should there be? More stages means less wasted effort and better focus, but maybe longer delays!

How early is too early for an EIA?

How far should EIA extend in space and in time?

How can it be best integrated with the planning and design stage?

Should it look at policies, plans and programmes as well as projects?

How can it be best integrated with existing licensing procedures?

How long should it be?

Perhaps the largest questions which have rarely been asked are:

What are the definable and precise tasks of EIA? How should they be carried out and by whom? And finally, how should this new and complex procedure be introduced as to ensure the constructive collaboration of all parties?

The experience of different countries sheds some light on these various questions.

Responsibilities

It is now widely recognized that the EIA should be carried out by the promoter of the project in conjunction with

the government agency responsible for licensing that type of activity. There are two basic reasons for this. Firstly, it is the proponent who is the potential polluter, and hence the 'Pollution Pays Principle' should apply. The second factor is that it is just the project proponent who knows most about the fine details of the project which might impact on the environment.

Purpose

While inevitably EIA studies have stopped projects because of the scale of their impact, it is widely recognized that the purpose of an EIA should be to help design projects which enhance the quality of the total human environment by examining alternatives, mitigating measures, or offsetting actions. This implies, of course, close and early integration of any environmental studies with the earliest stages of planning and design.

Size and Type of Project

There is almost unanimity in the requirement to subject major infrastruction projects to EIA. There is certainly a tendency to include also all major private industry projects, particularly those which either impact on the public domain through their use of public lands, or public funds, or through being of such a size as to require special licenses or permits from a grovernment agency. The difficult question to answer is, beyond these criteria, what types and sizes of projects should be submitted to EIA? Is it for example, possible to draw up a black list of types of projects which should be automatically subject to EIA? If so, then how are the varying degrees of sensitivity of the different environments where the impacts will actually occur to be taken into account? One approach which is being examined by the EEC is to prepare detailed lists of projects which might figure on a 'black list', plus a guide to fragile environments where all projects should be checked carefully. Another approach to this question is being pioneered in Malaysia. Here, 'black lists' are being prepared by the development agencies themselves, e.g. Industry,

Mines, Agriculture, Transoprt etc. and in addition include industrial estates. All other projects are considered as being exempt from an EIA study, *provided* that they meet the requirements for pollution control and land use planning and zoning. This approach has produced a very responsible attitude in the government agencies, with proposals carrying forward for major industrial, agricultural, urban and infrastructure projects, which clearly will have significant environmental impact. The Malaysian development agencies now feel involved in, and committed to, the new EIA procedure, and the procedure itself is likely to be more manageable and also links clearly to the other major environmental management instruments of pollution control and land use planning.

What Environment?

In 1965 the USA defined environment as social surroundings of man. Yet we see everywhere two contradictory trends. The first is that some governments, e.g. France, and most project proponents and their environmental experts, focus on the physical environment to the exclusion of the social environment. The other trend is for some governments, e.g. Canada and most panels which have to evaluate impacts, to realize that the social factors can be dominant. The reason for this paradoxical situation is that when talking of the physical and social environment, one is talking about two things situated at different levels. To put it clearly, in EIA one is interested in the physical environment impacted directly or indirectly by the project—hence one needs to look at that ***total*** physical environment in order to identify the potential impacts. But one is only interested in the *partial* social environment corresponding to the social consequences of those physical impacts which have been identified, and the social values attributed to those physical areas which have been modified. Taking a current example of the tiny fish called the Snail Darter, whose threatened extinction has blocked a major water project in the US. Here there is little question about magnitude of the dam on the hitherto unknown fish, but the question is how important is it, i.e. the social value of this tiny fish against the social value of the

project. Hence the social environment has to be taken into account—not necessarily as a primary impact area—but definitely as an area of secondary impact, and as a basis for deciding the significance of physical impacts.

Who Represents the Social Values?

Unlike air pollution standards or land use planning, EIA is concerned with actual individual target populations likely to be affected by specific actions or projects. As we have seen, there are social consequences to physical impacts as well as social significance of physical impacts. Who then measures these social consequences, and who evaluates social significance? Clearly not the project proponent or the development agency, their valid concerns are elsewhere in the economic and technological area. Perhaps not even entirely the local population, whose narrow parochial interests might override regional or national interests, i.e. the social consequences for the nation as a whole. In each social, political and cultural situation, a basis for a balanced introduction of social values has to be made. It might be by experts from ministries of health, eduction, welfare, culture etc. acting as representatives of some of the values of the threatened population. It might be through advocates putting forward the views and values of the local population. It might be through direct contact with the public, such as the series of public hearings held by Judge Berger about the proposed pipeline up the McKenzie Valley in Canada. Somehow the voice of the people must be heard. It has been said that it is the essential element of public participation which epitomizes EIA and which distinguishes it from other forms of environmental protection legislation. But how is the public participation to be managed so as to make it as effective as possible? We all know that public hearings tend to produce more confusion than illumination and consensus. Smaller, more informal groups, focussing on the particular project, seem more likely to achieve the desired results. This whole area is the least developed, and yet the most important in the whole area of EIA. Furthermore, if there is any single cause for the widespread failure of EIA and for it's current critical re-examina-

tion, it is precisely because of the failure to find a satisfactory procedure for the introduction of the correct balance of social values into the evaluation process.

How Many Stages?

A major problem of environmental impact assessment is that the environment is so vast, and the ability of any concerned individual to grasp complex information is so limited, then not only does a comprehensive study become impossible to evaluate, but in all the wealth of data it might even miss something significant.

A further role for "public participation" then becomes the orientation of the study away from areas of low significance, and towards areas of high significance.

For these reasons most EIA procedures comprise a number of stages, with some form of review or re-orientation between each stage. In the US for example, there is an environmental impact assessment which, in the event of major impact being discovered, is followed be the prepartion of a detailed Environmental Impact Statement (EIS). In Canada there is an Initial Environmental Screening, followed by an Initial Environmental Evaluation, in the event of environmental data being lacking, and finally, a detailed Environmental Impact Assessment from which a Federal review panel produces an Environmental Impact Report.

The multi-stage approach *might* increase the time for preparation, but it certainly decrease cost, increases accuracy and relevancy.

Timing

EIA should clearly be introduced as soon as possible in planning process. However there are genuine problems of timing—particularly if there is public involvement. If EIA is carried out too early, before the technical and economic details are established, it is difficult to identify the individual

activities which will cause impact. If EIA is carried out too late, after the completion of the technical and economic studies, it becomes very difficult and expensive—to modify anything to reduce it's environmental impact. For private projects with public involvement the problem is even worse, since early disclosure means considerable public debate without factual information, and late disclosure leads to charges of concealment and deception. The only solution is, on the one hand to develop a sensitivity to environment in all planners, so that they take environmental factors into account at the very earliest stage, and then bring in more and more 'outside' people as potential impacts are revealed. On the other hand, it means integrating more closely policy making, programme formulation and planning so that even at the policy making stage—other specialists with particular environmental concerns, as well as the concerned public, can make an input even before planning starts.

Extent of EIA in Space and Time

EIA is the only instrument in environmental management which enables one to cope in a satisfactory manner with problems of Transboundary Pollution, i.e. with global problems or with problems of long term effects. Pollution control legislation tends, for example, to lead to the use of tall stacks to reduce local ground level concentration, to the detriment of forest and lake, a thousand kilometers down wind. Land use planning tends to group heavy and dirty industries on rivers just before they flow over the border into the next country. Neither of them can cope with such global problems as the impact of fluoro carbons on the ozone layer of the atmosphere, or with bio-accumulation of a particular ecosystem. EIA, because it is primarily concerned with the ultimate target of a particular impact, whether that target is in the same country or not, on the same side of the globe or not, and whether it is now, in 30 years time, or for future generations, can do this.

Integration

As was said above, close integration with planning is

essential for EIA. Early integration can be achieved by the use of mixed teams in planning and design. The specialists should be chosen according to the impact areas identified in the initial screening of the project. Hence we see again the advantage of a multistage approach to EIA.

EIA of Policies and Plans

If EIA is designed as a major preventative measure in enviromental protection, it should be applied to the formulation of policy and the setting of plans. Thus, for example, development policies, economic policies and 5-Year Plans etc. could and should be subjected to EIA. As a result of the environmental evaluation of economic policies and of 5-Year Plans for example, environmental considerations will already be injected into economic thinking, and hence an early start will be made to the modification of projects for avoidance of major negative impacts, and the encouragement of projects with low or positive impact.

If economic policies are environmentally sound, then the programmes which flow from them will be sound, as will be the individual projects. Particularly if there is limited manpower available for environmental management. Carring out EIA at the policy, plan and programme level means less work needed at the detailed project level, and hence quicker, better results for less input.

Existing Licensing Procedures

In introducing new EIA procedures, care should be taken to integrate them fully with existing licensing and permit granting procedures. This means that there should be total participation of those who are involved in the existing procedures in the design and planning of the introduction of any EIA procedure. EIA should grow organically out of the institutional, legal, social, political and cultural infrastructure. It should not be imposed as a 'foreign' system from the outside.

Length

While being comprehensive, the main report or statement of impacts coming out of an EIA should be concise, otherwise no one will read or understand it. The USA has learnt this lesson after the Alaska Pipeline EIA which was some 10 metres thick! Recent proposals in the USA have required a maximum length of an EIS of 150 pages plus annexes.

The Tasks of EIA

The tasks of EIA are essentially fivefold:—

—Identification

—Prediction

—Evaluation

—Modification

—Communication

The first task consists of identifying the project activities which are likely to affect the environment. These activities cover the preparatory works, construction, operation, and final abandonment of a project, including any hazards or low probability events such as explosions, and also induced downstream activities from the distribution, use and disposal of the products it makes, or the induced economic activity, but also the induced upstream activities such as power supply, water, raw materials, bulk transportation, roads etc. This task is best carried out by the project proponents. In the introduction of any formalized procedure, it would be best to get all the agencies and sectors responsible for all types of projects to develop lists of activities which could give rise to impact and which should be included as a basis for a check list.

The other part of this first task is the identification of the components of the environment which are likely to be impacted on. These cover the whole range of air, water, land, noise, flora, fauna, man, in his physical as well as social aspects etc.

In drawing up this environmental check list, all those environmental, scientific and social welfare agencies and institutes concerned about the various areas should be involved in defining the major areas, and the sub components. One interesting aspect of drawing up the 'environmental' check list, is to stress environmental processes or effects such as soil erosion, flooding, intoxication etc., so that later one can ask the question about the impact of a given activity on that environmental process or effect—will it increase it, reduce it or leave it unchanged? The approach is a major innovative factor of the Canadian approach, and has much to commend it e.g. noise is dealt with more readily by this approach than by the conventional listing of components. These check lists can form the axes of a matrix of activities against environmental factors which can provide the first stage of identifying potential impacts.

The second task is predicting the impacts which have been identified. This then becomes the job of the specialists e.g. biologists, hydrologists, meteorologists, environmentalists, scientists etc. since it involves comparison with previous cases of impact from other developments in similar environments. It should also involve environmental modelling in order to predict the pathways linking source to target, it should also involve monitoring of existing environment and always a systems analysis approach to determining the existing situation, and predicting future changes. This stage also establishes base line date, against which all future changes in the environment will be assessed.

The prediction of impacts does nothing to indicate whether the impacts are important or not. Hence the third task is to evaluate the impacts. For this, a different approach is needed and a different group of specialists involved. They will include particularly those who are concerned with the human and social condition i.e. agencies and institutes for health, education, welfare, culture etc. It is particularly at this stage that the concerned public should be involved, since they are the ones who are likely to suffer impact, so they are the only ones who can say how important it is for them. The introduc-

tion of these social values, of course, needs to be properly structured, otherwise chaos results. Thus it is best accomplished through task or problem oriented mixed groups working together, rather than the common but chaotic public meeting or public hearing.

The fourth task is to develop the project and site alternatives, as well as mitigating and off-setting measures which will meet the needs of both the project proponent and the concerned groups. In this activity, the technical experts, engineers, ecologists, health officials, can play a major role, coming up with a satisfactory compromise based on the various needs previously expressed by the different parties.

The final task is that of communication, since justice (to the environment) must not only be done, but must also be seen to be done. Effective communication means that the information about the project and it's environmental impact should be comprehensive, concise and written in layman's language. In planning the form of communication, the licensing agency and the media should get together.

In fact, as we have seen throughout the discussion of EIA, participation is the key, not only for the success of the process, but also for its smooth and acceptable implementation. The secret of success is thus to involve all government agencies, and all concerned and involved groups and the media, in the development of EIA procedure from the very beginning, so that they bring insight to it and are motivated to make it a success.

4

Environmental Situation in India

Desh Bandhu

Introduction

ENVIRONMETAL DEGRADATION as a result of man's activities started when man the hunter settled down as an agriculturist. With the increase of population his requirements for food and needs have further increased pressure on land and resources, but with the application of science and technology man's standard of living was improved and he was able to control his environment. The industrialisation and technological advances set in process the deterioration of the quality of life. The unwise use of resources, raw material and energy has led to their consumption at the fast rate. The situation became more adverse with the introduction of non-biodegradable materials in the environment. The technological advances also created great disparities within societies. The economic situation of a few countries and classes within the society was improved at the cost of others.

The purpose of this paper is to analyse the environmental situation in India. The main land mass of India consists of the world's highest mountain ranges in the north, the largest alluvial plains in the center, drained by the Indus, Ganges and Brahmputra river systems, and the highly weathered plateau in the south. It has all types of climate and

biomes ranging from tropical rain forests to tundra and deserts.

Population

According to the 1971 census report the population of India was 548 million. The present population has touched the 650 million mark. Having 2.4 per cent of the area and 1.5 per cent of the income of the world, India has 15 per cent of the world's population. The population growth rate is 2.48 per cent. At present 21 million babies are born every year at the rate of one baby every 1½ seconds. The death rate is 1.4 per cent, giving a net addition of 13 million per annum, more than the population of Australia.

We have to feed our large and rapidly growing population. They have to be provided with the basic facilities of life and have to be removed from the grip of poverty. This has placed great demands on the country's natural resources and still continue to do so. In order to raise the standard of living of the people and to provide them with the necessary amenities and services, rapid urbanization and industrialization took place.

The increase in population has had its impact on the rural and urban environment. The growth of population and its rural-urban distribution in India is given in Table 1. In rural areas, availability of arable land has now become a problem of great concern. In addition, with the growing emphasis on industrial production of articles of daily use, production by masses, particularly by the rural artisans, suffered a severe setback. These two factors coupled with the creation of job opportunities in the urban centres has bled to substantial migration from rural to urban areas. In urban centres the rapid growth in population has not been matched by a corresponding development of services and this has contributed to the degradation of urban services.

TABLE 1

Growth of population and its rural and urban distribution during 1961-2001

Year	*Population (in million)*		
	Total	*Urban*	*Rural*
1961	439	79	360
1971	548	109	439
1981	668	150	518
1991	801	205	596
2001	945	278	667

Source: Indian National Report 1976 to UN Habitat Conference.

Both urban and rural areas share the same problems. Only 4.3 per cent of the population in rural areas is provided with safe drinking water. Severage is practically non-existent in the villages. About 25 per cent of the population in cities live in slums and squatter settlements.

Deforestation

We have plundered our priceless forest resources for fuel needs. Large forest areas have been cleared to supply land for various purposes. This has also changed the local climate. There has been increased soil erosion, floods and droughts. All this now requires costly remedial measures. The deforestation in the catchment areas has created severe problemes of siltation of our dams and reservoirs. Table 2 shows the sedimentation rates in some of the reservoirs. The siltation has resulted in loss of fertile soil and reduction in productivity.

The deforestation in the mountain areas of the Himalayas is more serious. The deforestation, along with misguided forest management methods, grazing, construction of hydrological projects, faulty construction of roads, wrong methods of farming, mining, and fire, all these lead to soil erosion and this results in the disappearance of flora and fauna. The lakes and aquatic ecosystem in the mountains are also affected. The changes in the mountains have great impact on the plains and valleys. The water in the springs and rivers is reduced and the precipitation is also affected by misuse of mountain environment. The mountain range in the lower Himalayan region is acquiring the characteristics of deserts.

TABLE 2

Sedimentation rates in some reservoirs

Project with year of first impounding of water	*Originally estimated life (yrs) to fill dead storage*	*Revised estimated life (yrs) to fill dead storage*	*Number of years needed to fill 50% of live storage*	*Balance life (yrs) to fill live storage*
Bhakra 1959	88	47	147	105
Hirakud 1956	100	35	62	41
Maithon 1957	245	24	60	36
Manchet 1959	75	12	21	8
Ramganga 1973	185	47	223	177
Thungbhadra 1959	36	3	40	37
Nizamsagar 1931	178	5	35	15

Source: Kayastha and Juyal, 1979, from Man and Forest, edited by Gupta and Desh Bandhu, 1979.

Nature Conservation

India is endowed with immense genetic resources. These are largely found in the forest areas and in other ecosystems such as mountains, lakes, rivers, marshes, swamps grasslands and deserts. We have a large number of national parks and nature reserves for the protection of natural areas protection of endangered plants and animals, but some of the important endemic species are ignored.

It is unfortunate that in India the management of wildlife areas and parks is carried out in an unscientific manner. The forest officials who look after these areas are not properly trained in wildlife techniques. The main drawback is the lack of information and data on the structure and functioning of the ecosystems.

Some of the areas which should be protected as nature reserves or national parks are: North Eastern Hill region, this area is very rich in plant and animal species including rare legumes and medicinal and ornamental plants: similarly, the Rishi Ganga basin areas, including the Nanda Devi Sanctuary in the Himalayan region, which are rich in typical alpine flora and fauna need immediate protection from human interference; in South India, the Wynad-Karnataka plateau comprising the wildlife sanctuaries of Mudumalai, Bandipur, Wynad, and Nagarhole also has rich flora and fauna, including rich forest areas and wild animals; in deserts the Mount-Abu, Jaisalmer-Barmer belt and the Bharatpur and Ranthambore sanctuaries also deserve protection. Other areas of vital importance are Silent Valley in Kerala, Flower Valley in U.P., Simplipal Hills in Orissa, Rarvati and Panga Valleys in Himachal Pradesh. All these areas need the urgent attention of conservationists to protect the natural resources which are in danger due to human interference.

Toxic Substances

Food and water are the main sources through which man meets the daily requirements of minerals and metals. The

same, with the addition of air, are also the media through which man is exposed to various toxic metals, and substances. The excess intake of metal is excerted from the body through urine and feaces. The fraction of metals absorbed by the body may accumulate in various tissues either as metals or organometal complexes.

There is a number of industries which wholly depend on metals and release toxic substances. These substances and metals are dispersed along with other wastes in the environment as effuluents or atmospheric emissions. These metals pollute the soil, water and air. The heavy metal pollution of the soil is increasing due to human activities such as the excessive use of fertilizers, insecticides and dumping of the industrial wastes. Other common sources of the soil contamination in the urban areas are sewage disposal, effluents from industries, such as from sugar industries etc. The metals and toxic substances in the atmosphere are due to transportation, effluents in smoke from industries, power generation, dust and refuse burning.

The effect of toxicity on human health is not well studied in India. Some of the toxic metals are Vanadium, Chromium, Manganese, Cobalt, Nickel, Copper, Zinc, Cadmium, Arsenic, Mercury and Lead. Lead, Nickel and Cadmium imply serious health hazards while Mercury is a deadly toxic metal.

The excessive use of insecticides and pesticides such as D.D.T. is also posing serious problems. It is feared that the impacts of these substances are very severe in the long term. Efforts should be made to reduce the use of toxic substances and non-biodegradable materials.

Energy and Environment

The amount of coal and petroleum used in one year, took nature a million years to produce. As a result of the reckless use of non-replaceable, non-replenishable sources of power and energy by the industrialised nations for the last 200 years,

we are seriously threatened with a fuel shortage of unprecedented magnitude within the lifetime of us all. Energy is most vital for all development activities including agricultural development. So far in India, electricity, one of the important form of energy, is used mainly to feed the urban population. Table 3 shows the sectorwise energy consumption in India.

The main energy source in India is coal reserves. Coal is used in steel-making, railways, thermal power stations, domestic cooking and a variety of industries like cement, brick, paper, textile and chemical, etc. The mining of coal and the smoke and particulate materials from the coal in various processes at various stages cause serious environmental problems.

Every evening industrial cities in India are covered with smoke. One of the examples which can be mentioned here is the I.P. Power Station in New Delhi. The smoke from industries causes serious diseases in living organisms, including man. The sulphur-dioxide in the smoke has been found to be a serious menace to historical monuments including the famous marble palace Taj Mahal.

The other sources of energy used in India are oil, nuclear fuels, hydroelectric power and non-commercial sources of energy such as fire-wood, agricultural waste and cow-dung. The dangers of pollution from oil refineries and the limited quantity available in India, and the fear of radioactivity from nuclear energy are well known. The construction of hydrological projects for electricity leads to large-scale damage of forest cover and vegetation. There are several other public health problems associated with the construction of dams.

In India, there is an urgent need to explore the possibilities of the use of non-commercial sources of energy. The biogas from organic waste and human waste is given priority to solve energy problems in rural areas.

The construction of hydro-electric projects and dams should ensure full protection to the nature and forest cover.

TABLE 3

Energy consumption in India by sectors

Sector	*Energy*	
	Kilo calories $\times 10^{12}$	*%of the Total*
Industry	345	22.4
Transportation	160	10.4
Govt. & Commercial	35	2.3
Agricultural	30	2.0
Urban Domestic	83	5.3
Rural Domestic	890	57.4
	1643	100.0

Source: Fuel Policy Committee Report 1974.

The catchment areas should not be disturbed. The planning and the selection of the site should be based on ecological considerations and not on political considerations. Solar energy research activities are given prime attention to develop alternative sources of energy in India.

Human Settlement

Table 4 gives an idea of some components of environmental quality in human settlements in India. About 80 per cent of the population in India live in villages. The villages

are hardly provided with the basic amenities of life. The population in villages are not provided with safe drinking water, there is hardly any sewerage system and the drainage system is open and not maintained. There is a big migration from rural areas to urban areas. The large cities in India are doubling every 3-5 years.

TABLE 4

Some components of environmental quality in human settlements

Type of service	*Rural (%of population)*	*Urban (%of population)*
Water supply (Protected (March, 1974)	4.3%	83%
Sewerage (Water-borne) (March, 1974)	Negligible	38%
Drainage (Complete or partially covered)	Negligible	36%
Electricity (March, 1974)	40%	86%
Housing (March, 1971)		
Type: Pucca (Durable)	18.9%	63.8%*)
Semi-pucca (Semi-durable)	37.6%	23.5%
Kachcha (Non-durable)	43.5%	12.7%
Cover-crowding:	*Pers/room*	*Pers/room*
One room	39.6% 4.7	41.7% 4.6
Two rooms	28.8% 2.8	28.1% 2.9
Three rooms	14.2% 2.2	13.6% 2.2

Source: National Buildings Organisation; Ministry of Works, Housing and Urban Development; Govt. of India 1975.

(*) In metropolitan cities nearly 25-30% of the population lives in slums and sqatter settlements.

This has created social and economic problems. The people who migrate from rural areas to urban centres in search of work and better facilities of life are not rapidly absorbed in the urban systems. This has created overcrowding in the cities in the shape of slums and squatters. Soon 80 per cent of the low income population of the developing countries, more than half of the world's urban population, will be living in slums. Youths and children will live in dark places and without proper facilities of drinking water and facilities required for healthy life.

There is an urgent need for better and cheaper housing facilities in rural as well as in urban areas. People living in sub-standard places like slums should be provided with safe drinking water and basic facilities of life.

Land Use Pattern and Land Utilization

Table 5 shows the pattern of land utilization in India during 1970-71, and forecasts for 1985 and 2000. India has 15 per cent of the world population and 2.4 per cent of the world area. Land is a limited resource and has to be put to a variety of uses. Usability of land is further limited by soil conditions, terrain and location. The first charge on land is to produce food and other materials such as cotton, jute, etc. Land is also required for grazing purposes and mining. A certain portion of the land will be required for forests, preservation of flora and fauna and for the development of human settlements.

The pattern of land utilization projected for the end of the century, incorporating the national forest policy to keep nearly one-third of the total land under forest, would restrict the availability of land for further non-agricultural purposes. Better managament techniques to reclaim unusable areas, revines, saline-land and waterlogged areas, for the protection of suitable land from erosion or desertification, and for the use of derelict, blighted and undeveloped or under-developed land in human settlements, will require extensive scientific and technological inputs ensuring optimum

ecological balance between human activities and natural environment.

TABLE 5

Pattern of land utilization (million hectares) during 1970-71, 1985, 2000

	1970-71	*1985*	*2000*
Area under forest	66.0	70.00	70.0
Area not available for cultivation	45.4	54.0	56.0
(i) area under non-agricultural uses	16.2	21.5	26.0
(ii) barren and unculturable land	29.2	32.5	30.0
Other uncultivable land excluding fallow land.	33.8	32.5	29.0
(i) permanent pastures & other grazing land	13.3	14.0	15.0
(ii) land under misc. tree crops and groves not included in net area sown	4.4	5.0	5.0
(iii) cultivable waste-land	16.1	13.5	9.0
Fallow land	19.7	16.5	13.0
(i) other than current fallows	8.6	7.0	5.0
(ii) current fallows	11.1	9.5	8.0
NET AREA SOWN	104.4	145.0	150.0
Total reporting area	305.3	318.0	318.0
Area for which no returns exist	22.7	10.0	10.0
TOTAL GEOGRAPHICAL AREA	328.0	328.0	328.0

Source: National Commission in Agriculture 1976. Ministry of Agriculture and Irrigation.

Further evaluation of ownership of land and land tenure may also need to be considered to prevent its exploitation. The land which is limited should be wisely used for agriculture, forests, extractive industries, major industries and for human settlements. Land use practices should be based on ecological considerations.

Environmental Education and Awareness

A brief survey of India's environmental problems is given in the preceding paragraphs. The seriousness of the problem can be easily realised. Many of the problems are due to under-development and ignorance. The general public are not aware of the environmental problems and their occurrence. Millions of people are poor, hungry and withbut the basic needs of adequate food, cloth, shelter. health and education. This is not only an intolerable situation in terms of humanity, but it has various environmental consequences. There is urgent need to educate the masses and to make them aware of the problems which are very serious and are concerned with day-to-day life. The awareness and education must be acquired by the society from programmes that fall outside the formal education system, since the majority of the population still do not have adequate access to formal education. In India there are some efforts at both formal and non-formal level to educate people, particularly at young age; some of them are highlighted here.

Environmental education in India is based on the following principles: to improve the quality of life, to create an awareness among people on environmental problems, to develop necessary skills to solve environmental problems, to make it possible for people to participate in decision-making concern in the environment, and to provide an awareness of economic, political, social and ecological interdependance.

There is a number of activities, disparate, uncoordinated though they are, both in formal and non-formal systems. Environmental education has been included in the school systems. The material is developed by the NCERT, (National

Council for Teacher Education), which is under the Ministry of Education. The environmental education is also included in other disciplines such as ecology, economics and social sciences. There are a number of universities which offer courses on Environmental Biology and Environmental Sciences; the public health institutes, civil engineering departments in Engineering Colleges, and medical courses include compoents related to environmental problems. A number of inservice training programmes by agricultural faculties and the Forest Research Institute and College, are also organised. Some of these institutes offer degree programmes which are directly related to the environmental protection and training.

The environmental education and awareness by the nonformal agencies is very important. There have been several movements and successful efforts by these groups. The Chipko Movement is the Himalayan region to save the forest cover from felling, the Bombay Bachao Committee to highlight the problems of Bombay city, Taj Mahal protection movements, Silent Valley Protection Committee and several others, are sufficient to mention. There have been efforts to educate the masses through press and mass media, and to influence the decisions at different stages which are/were not environmentally sound.

Environmental Legislation

The need for protection of the environment, forest, and natural resources in included is the Indian Constitution. In addition, there are numbers of Central and State legislations. It is outside the scope of this contribution to list them all but some of the important will be mentioned.

Water quality

A Central Legislation entitled "Water Prevention and Control of Pollution Act" is in force in country. It was passed by the Indian Parliament in 1974. Seventeen states have also adopted this legisation. The Central Act provides for the Constitution of Central Water Pollution Control Board and State Boards. The boards at Central and State level have

started some activities to monitor rivers, takes and the effluents from the industries.

Air quality

The Government of India is soon to enact a comprehensive legislation to control air pollution. A Motor Vehicles Act is already in force. A few states have their own Smoke Nuisance Acts which, among other things, may regulate the construction of new industrial units of a epecified category in any particular zone.

Regulation on land use

The Indian Constitution has regulations on land use and its development is subject to state approval. The individual states have generally adopted the "Town and Country Planning Act" which stipulates land use planning and governs land use decisions. In addition, the various Land Revenue Regulations determine the use of land either for agricultural or non-agricultural pruposes.

There are legislations related to Slum Clearance and Urban Land Ceiling Act. These are directly related with the environmental considerations. Legislation such as the "Insecticide Act 1968" empowers the Government to prohibit import, manufacture and sales of pesticides. Adequate provision is made for analysis, inspection and establishment of laboratories for these purposes.

The Central Forest Act and the State Forest Act is implemented through the respective forest departments. These acts provide necessary legislative support for forest management. The Wildlife Protection Act of 1972 forbids the killing or hunting of certain specified rare species of animals. Under the Act, advisory boards are set up to recommend measures to protect wildlife.

Some states have a Control of Noise Act. The Motor Vehicle Act empowers the Government to take steps for reduction of noise caused by vehicles.

There is a number of Acts related to Protection of Cultural Property such as monuments; Radiation Act (Atomic Energy Act, 1962), relates to the radiation from the radioactivity; Merchant Shipping Act and Maritime Zones Act, 1976, are related with the marine pollution. The legislation on toxic substances is also enforced.

It has been realised that although there is a number of acts and legilations which relate directly or indirectly to environmental protection, the participation of people in implementation of these acts is most vital. The awareness of people, particularly the people in rural areas, is most important. We have to learn how to live with nature. The Indian culture emphasizes harmony with nature. The ancient Indian scriptures recognised that material resources were not infinite and the concepts of balance and cycling were stressed. The "Atharа Veda" says: What of thee I dig nout, let that quickly grow over. Let me not hit thy vitals or thy heart".

5

Some Socio-economic Issues in Social Forestry

Jeff Roman

SOCIAL FORESTRY is an effort to improve village welfare and reduce pressures on forestlands by developing various wood-fuel-fodder-forage-food production systems on unforested village and government lands. It is an effort to intensify production, in ecologically and socially viable ways, on lands that have been largely beyond the purview of development programs in the past, and thereby reduce pressures on lands better left under administered forest management.

Social forestry has special features that have important socio-economic implications. First, social forestry crops take a long time to mature, compared to other crops grown by villagers. Second, they require community mechanisms for protection, distribution of benefits, and absorption of costs. Third, social forestry involves government interests of two kinds, the promotion of rural development and the prevention of land and forest deterioration; the potential conflicts among these interests are to be resolved by new packages of technology, organization, and administration that are resource-conserving, productive, and feasible. Fourth, as social forestry will be undertaken mostly on government lands, whether of the Revenue or Forest Departments, the distribu-

Paper was used as the background material during the seminar.

tion of rights and responsibilities between villages and the government, is a central question. Taken together, these four characteristics differentiate social forestry, and many DPAP activities, from all other government sponsored development efforts in India. They also raise a special set of socio-economic issues.

1. Long Maturation Time of the Harvest

Villagers must be prepared to wait for the benefits of a social forestry crop. They must also be willing to sustain protection of the crop and to undertake related investments that will not generate income quickly. To do so, they must expect that the economic benefits of waiting are substantially greater than those obtainable through current land uses. Immediate benefits are more secure than those predicted for some future time. If villagers think their present land uses will produce half the income in two years that they would expect to obtain from social forestry in four, they will prefer present uses because the benefits are more closely at hand.

We know very little about the economics of social forestry crop combinations. What are the net economic returns of various wood-fuel-fodder-forage-food production systems, and when will they be available over time? How do they compare with returns to current patterns of use? How do social forestry economics differ in different social and ecological conditions? In other words, what are the incentives for adoption of the new technologies under various conditions? Finally, how will incentives change with changes in market prices and marketability of produce?

2. Community Organization

While the economics of social forestry may appear advantageous to a village as a whole, they may not appear desirable for various village members who expect to lose more and/or gain less than others in a shift from present to social forestry uses. These members would be most prone to break protection of the crop or neglect other responsibilities -

required for a viable social forestry system. Deviance might be avoided if the net economic returns of social forestry are so high as to provide a sufficient minimum for all village members. It can also be controlled by community organization which punishes offenders or compensates potential deviants sufficiently to bring their incentives into harmony with majority interests.

We need to know who potential deviants are likely to be. Who will lose most from shifts in land use? Who may not expect to gain a fair share of benefits and responsibilities? We also need to know how well the community can organize itself to insure compliance with its collective will. How strong and interested are community leaders? How unified or divided is the community? Which segments of the community are sufficiently neglected to be outside any expectation of benefit or voice in collective decisions? How can such questions be answered as easily as possible, and how can answers be used to prescribe organizational requirements in different conditions?

3. Government Interests

The government has interests in social forestry that go beyond the economic calculations of the villagers themselves. It wants to promote equity and the general welfare through rural development. It wants to curtail the destructive effects of present resource use on people beyond the village or in future generations. In other words, the government has incentives to promote social forestry even village economics, by themselves, provide inadequate justification for it. It has incentives to use the promotional tools at its disposal. These tools include, for example, the provision of tax relief for villages and individuals undertaking a social forestry project, the subsidy of social forestry through provision of technical assistance, planting stock, management of market prices and stimulation of marketing possibilities, support for concessionary loan programs that provide annual payments for a deferred crop, or transfer of land use taxing and licensing authorities to local organizations. The effect of such mea-

sures is to improve the village economics of social forestry and bring them in line with interests of the society at large.

Thus, social forestry raises a number of policy issues. To what extent might these various tools apply in social forestry? What has been the experience with them in, for example, the promotion of agricultural development? Which are feasible and seem to have the effects desired? Which seem most promising for social forestry, what combination, and with what anticipated effects on village incentives? What do answers to these questions suggest for policy adjustments?

There is a related set of questions. The ability of the government to project it interests into village calculations depends on how its various interventions are organized for the purpose. In its narrowest sense, social forestry is a set of technologies. In its broadest sense, it is a term for integrated development of lands and communities that have previously attracted little developmental interest. Either case raises questions about how government can best organize itself for the efforts required to fulfill its intentions.

The qestions might be placed in two categories: the organization of agency activity and the levels, along a government community continuum, to which various responsibilities for social forestry should be assigned. In the first, for example, should social forestry be the responsibility of one agency? If so, what should its professional competences be and how should they be organized? Should social forestry be the responsibility of a coordinated group of agencies? If so, what agencies should be included, with what responsibilities and competences among them, and within what mode of coordination? As social forestry may ultimately require competences in animal husbandry, livestock management, agri-silviculture/horticulture, crop production, marketing and finance, as well as forestry, these questions seem worth consideration. Presumably, the scope of social forestry cannot become too broad to require inordinate efforts at coordination, yet cannot be too narrow to have insufficient impact on villagers' incentives.

Second, at what levels should various responsibilities for social forestry reside? What functions are most appropriately undertaken at village, panchayat, block, district, state and national levels? For example, the national government may be most suited for regulation of market conditions, the state government for adjusting taxation policies and planning social forestry programs, the district for organizing project execution. The block for inter-agency coordination, the panchayat for local taxation and the village for project protection. Each level would have its comparative advantage in carrying particular functions. What are these comparative advantages? How sufficient are capacities at each level for the functions involved? What links among levels are necessary to insure that the program functions properly? How can answers to such questions be obtained, and what do they suggest for program organization?

4. The Shares of Government and Communities

Most land on which social forestry will be undertaken is non-forested government land in which villages may have rights of various kinds. Social forestry implies a shift in government-village rights, or. rather, an increase in land productivity that will require a new allocation of benefits. The share of benefits and costs allotted villagers will affect the strength of their incentives for adoption of new land use practices. Presumably, the larger is villagers' share of net benefits, the stronger will be their incentives. At some minimum share, villagers will be indifferent to the success or failure of their project: below that, they will have insufficient interest to sustain it. In addition, the expectations determining their preferences will be influenced by how secure they feel that the share allotted them will actually materialize.

Social forestry involves an agreement, implicit or explicit, between the government and villagers regarding the distribution of benefits and costs in social forestry. An explicit agreement has the advantage of security which, by heightening expectations of benefit, strengthens incentives for adoption. What various arrangements are possible, between

the government and communities, with respect to decisions about land use and distribution of land benefits and responsibilities? If shares are biased in villagers' favour, perhaps requirements for other forms of governmental intervention will be less than if the case were otherwise. If shares are biased toward the government, perhaps additional tax and subsidy benefits would be required to promote villagers' interest. Thus, "share" policy will affect village economics of social forestry directly, and will also affect the level and kinds of governmental intervention that may be required. How might such considerations be translated into policies, general agreements, and specific provisions suited to local conditions?

To summarize my comments on these four socio-economic characteristics of social forestry, let me proceed through the following line of argument. Villagers will sustain social forestry to the extent that they perceive its benefits to be greater than those obtained through current patterns of activity. This depends partly on the suitability of the technology offered them. To the extent that the introduced technology becomes less advantageous, relative to present uses, organizational difficulties will increase because a growing number of people will find their interests unsatisfied and will react to the project.

From the villagers' point of view, the economics of social forestry can be improved by the provision of tax benefits and various subsidies, changes in marketing conditions that increase effective prices for their produce, shift of shares toward the villagers, and explicit arrangements that secure villagers expectations at a reasonable level. The economics will be affected by how effectively the government is able to implement its social forestry policies and programs. The effectiveness of implementation will depend on how the government organizes its expertise, how well it understands what works and does not work in different conditions, and how responsibilities are distributed among various levels of organization according to their comparative advantage and skills.

From the governmental point of view, public interests in social forestry are to be secured at minimum cost. This means that some combination of policies will be sought which achieves necessary villagers' incentives with a minimum of intervention and/or internal adjustment. Policy combinations may include consideration of needs for, and comparative impacts of,

(a) improvements in technology

(b) re-organization of governmental responsibility, among agencies and levels

(c) change in taxes and subsidies

(d) shifts in share agreements

(e) regulation of effective market prices for commodities and loans

The potential of various combinations will emerge over time.

A basic idea in rural development is that successful community mobilization for one activity can lead to gradually more ambitious undertakings. The choice of initial activity influences the nature of subsequent "spin-offs." These occur to the extent that there is some translation of experience into other forms of action. The size of the start is less important than its quality and that of the follow-up. Social forestry can be viewed as initiation of a sequence of activities. What that sequence might be merits some consideration as it will be influenced by the initial stage.

A similar logic applies to government agencies. It is implicit, for example, in social forestry planning processes, by which the means to achieve objectives are tested against their results and refined, and how they can be used to build organizational capabilities for an ever-larger and more effective program. Thus, while the scope of social forestry

can seem rather broad, the initial stages are necessarily constrained to achieve quality and the capacities that will ensue.

This kind of development, whether in communities or agencies, is a social process of importance in social forestry which, over a decade or so, is expected to proceed from selective beginnings toward more general approaches to resource conservation and rural development through improved utilization of village land management circles. What patterns of development might be projected for villages and communities? How might the better be determined over time? What needs to be done now to insure the reasonable translation of experience into concrete approaches and skills? I've dealt partly with this topic in my discussion paper on planning, but the topic is one for which no amount of consideration is ever sufficient.

The foregoing suggests a number of socio-economic issues in social forestry that deserve attention.

1. The economics of technologies proposed for application in social forestry, factors that cause them to vary under different conditions.

2. The economics of present uses of non-forested government and village lands.

3. The economics and social organization of grazing.

4. Village requirements of forestland produce to satisfy basic needs and gain reasonable economic progress

5. The assessment of village society to prescribe alternative modes of community organization for social forestry.

6. Alternative government-community "share" arrange-

ments, how they can be assessed and their effects predicted.

7. Alternative ways to organize the Forest Department for social forestry, their implications and effects.

8. Alternative modes of inter-agency coordination for development of non-forested government and village lands, their possible implications and effects.

9. Alternative allocations of functions for social forestry between different levels of government and between government and communities, implications and effects, criteria for choice.

10. Possible tax/subsidy schemes for promotion of social forestry.

11. Possible state and national policies for promoting improved use of non-forested non-cultivated village and government lands.

12. Development of marketing for social forestry produce and the regulation of prices for production incentives.

13. Means for financing long-maturing community crops, how existing programs work, and what innovations are desirable.

14. Alternative approaches to village mobilization and training for social forestry, their requirements and effects.

15. Management models for village land management circles, their comparative suitability in different conditions.

16. The planning process in social forestry, its purposes, functions and requirements.

17. Priorities for R&D in technologies of social forestry.

18. Alternative strategies for social forestry-based local and national development programs.

At present, few analyses are available to inform us about these issues.

6

Population, Employment and Environment

S. Venkatesh

NOT A DAY passes without some report or the other appearing in the press vividly foreboding the environmental catastrophe we are in for, in the nearfuture—a catastrophe in terms of total destruction of enviromental quality, collapse of man and his civilisation. A good many of these write-ups refer to the upper limit to the world population, set by our resources and by the pollution hazards. Though there is no definite answer to the actual sustainable limit of population of the earth, it is clear our present exponential growth is fraught with serious risks.

Clearly, population explosion in the coming years is inevitable. We have therefore to make the best of the situation to avert the tragedy or at least stall it. Human numbers will have to be treated as an asset and developed as a resource. Appropriate programmes are feasible to make this potential resources more productive, and also to improve our environment in the process.

An analysis of the demographic trends would highlight

The views contained herein are expressed in the author's individual capacity.

the dramatic difference in the rate of climb of the human population between the more developed and the developing nations. Developing countries are generally characterized by excessive population. Widespread unemployment and under-employment are the other common features. Such unemployment, marked by abject poverty, miserably poor quality of life has a chain effect on our environment. This chain is to be broken by initiating appropriate development programes, based on sound environmental considerations and on technology suited to local conditions.

There is an optimistic school of thought that the catastrophe forecast is not necessarily inevitable. They argue that like the Green Revolution (unheard of about 20 years ago) coming to our rescue to solve the food problem, technology will find a way out to our population problems also.

Either way we have to act now. Among other steps, provision of employment to the masses, especially in under-developed countries, would greatly help in improving our environment. Some of the sectors in which such employment-oriented programmes could advatageously be taken up are mentioned, by way of illustration, in this paper.

Demographic Trends Limitations for Accurate Projections

Predictions about man's potential growth must take into account the inter-relationship of man and his environment. When we predict the extent of growth over a short period of time, it is perhaps understandable if we ignore the other components of the ecosystem and their effects on man. However, when we attempt a prediction far into the future, quite a few other variables also need to be examined. Clearly, world population cannot keep growing widly until the time when there is not enough food, water or room in which to stand. The increasing population size may cause a gradual deterioration of levels of health and nutrition and increase the number of areas beset by poverty and overcrowding. Population having thus been rendered vulnerable, epidemics and other natural causes may have considerable influence on the size of the

population. Possible innovations in technology, exhaustion of fuels and other resources are other considerations which matter. In result, any long-term population projection is not a mere extra-polation of existing trends but is marked by inter-locking cause-effect pathways.

In view of these variables, even the best demographic projections often tend to be vague. While such projections in respect of developed countries are relatively more precise, the corresponding estimates for under-developed nations are clouded.—For instance, the population of developed nations (around 1.1 billion in 1970) is expected to stabilise between 1.3 and 1.8 billion. On the other hand, for the under-developed nations, the pattern is not clear. Their population which was 2.5 billion in 1975 is expected to hover anywhere between 4 billion and 11 billion by 2050 A.D. depending upon the pace at which these nations are able to reduce the fertility rate to the replacement level. The range between 4 billion and 11 billion is too vast and this would only serve to highlight the influence of variables in these calculations.

Different demographers have adopted different methods to describe the population explosion. One such way is to describe the acceleration in population growth in terms of doubling time and we are constantly reminded how the first doubling took place (from 1 billion to 2 billion) between 1825 and 1927. The second doubling (i.e. from 2 to 4 billion) was accomplished in just 48 years (1927-1945). According to U.N. estimates, our population will rise from 4 billion to 5 billion in just 10 years (1975-1985) at the rate of 100 millions per year. By 2000 A.D., the population is expected to be between 6 and 7 billion. About the number of people that can live on earth—however uncomfortably—most demographers agree that only 2 or 3 more doublings are possible. They agree, "we are pushing against a ceiling that will be reached within the life times of children already born."

On the other hand, there is an optimistic school of thought who feel that all is not lost. They hold the view that the threatened holocaust is not inevitable. Just as there is

population explosion, there is also a knowledge expulsion. They believe that technology is going to find a way out and that man will realise—or will be made to realise—the peril he is heading towards and would make suitable adjustments to limit the population.

Position in Developing Countries

While the human population growth during the past few years is alarming, there is a marked difference between the developed and developing countries is this regard. Today, about 70% of world's population lives is under-developed nations. By 2050 A.D., this share is expected to rise to 80% and will continue to rise thereafter. This shifting balance of population will probably bring more abject poverty in many areas of the world, because the economic cololary to our demographic predictions is that the poor nations will become poorer, as they become more and more populous.

In absolute numbers, the distribution of population between the developed and the developing countries is as follows:—

Area	*1965*	*1970*	*1975*	*1980*	*1985*
					(billions)
World	3.28	3.63	4.00	4.45	4.93
More developed	1.03	1.09	1.1	1.2	1.27
Less developed	2.25	2.54	2.87	3.2	3.66

It will be seen that the difference in the rates of climb-between the more developed and the less developed is quite dramatic. While the population of the developed nations would rise only by 25% between 1965 and 1985, that of the less developed countries would be nearly three times higher, i.e. nearly 70% during the same period.

Similar marked difference is evident even with regard to mortality and fertility. More developed nations are characterised by low mortality and fertility, as seen from the table

below:

	Birth	*Death*	*Increase*
More developed (1965)	18	9	9 (per thousand)
Less developed (1965)	40-41	16-17	24 (per thousand)

This alarming rate of population growth has led, among other things, the inequality in time and space. Inequality in space includes both between and within the countries including the concentration in cities. Inequality in time has already been referred to in the preceding paragraph about the marked difference in the population growth rates of different countries.

In developing countries, the sequence of likely events which will limit the population will not be a pleasant one. Various setbacks are likely to precede significant decreases in birth rate. There may gradually occur a general state of under nutrition, leading both to increased suspeptibility to disease and to lower fertility. Contamination of drinking water may lead to widespread epidemics of contagious diseases, etc.

Consequences of excessive population density are too well-known. As this density in any area increases, each person's share of available resources as land, water, fuels, wood, metals and other resources must necessarily decrease. Studies attribute many evils like violence, disunity and unheavals to such excessive population density.

Situation in India

India is the second largest populous country in the world, accounting for more than 15% of the world population, accommodated in just 2% of world land area. The population explosition witnessed in the recent times has brought, in its wake, a crop of problems, by way of excessive strain on resources, steadily decreasing standard of life and adverse effects on general environment.

Particularly since 1951, the population has increased alarmingly, from 361 million (1951) to 548 million (1971). As on today, it is estimated to be 600 million and is expected to reach 945 million by 2000 A.D. pushing up the overall density from 177 sq.KM (1971) to 288 sq.KM (2000 A.D.). 80% of the population today live in rural areas (spread over half a million villages). In view of the pressure on land, migration to urban areas is steadily on the increase. The urban population (of 110 million in 1976) is expected to go up to 240 million by 2000 A.D.

The pace of urbanisation has been quite rapid since 1910. From 8.3% during 1911-21, it rose to 19.11% in 1921-31, which jumped up still further to 41.4% in 1951-61. Over the last 60 years the urban population has increased by 83 million and has more than quadrupled itself. Its percentage to total population during this period has gone up from 12.3 to 19.9.

Any further increase in urban population would add to the strain on the civic services which are already far below the minimum requirements. According to one study, 25-30% of population of Indian cities live in slums or squatter settlements. In Delhi alone, more than half a million people live in 1300 and odd clusters of slums. In that capital city, squatter population is expected to be growing at 12% compared to the population growth of 4.5%.

The position is bound to worsen as population continues to explode. As on today, there are only about 8 cities with more than 1 million population. By the end of the century, there would be around a score or more of such cities, with all their attendant problems.

This increased pressure of population is chiefly responsible for the steady decline in the extent of forests in India. Over the past 25 years, about 4.2 million hectares of forests are thus lost. Due to the resultant soil ersion, the storage reservoirs built at enormous costs are fast getting silted up. The extent of grazing lands is shrunk. The recent floods all

over Northern India, said to be a record over the past 100 years, are now a matter of common knowledge.

Among the numerous other problems thrown up by the population explosion, the problem of unemployment needs a special mention. Though no precise data is available in this regard, one estimate places this around 21 million people (1977) as fully unemployed. The under-employed would also be quite sizeable. The addition to the labour force is expected to be about 5 million per year. This would mean that in the next 10 years, our country will have to provide around 70 million jobs to attain a reasonable level of employment.

This is a stupendous job. Yet, it is of paramount importance for, without employment, the population becomes not only unproductive but would end up steady consumption of resources and deterioration of environment.

Efforts Made in India for Environmental Preservation

As in other countries, in India also, there is a steadily growing concern over the present and the future state of environment, especially in the context of population growth, industrialisation and urbanisation. It is increasingly realised that in the field of environmental preservation, prevention of any possible environmental damage is far easier and cheaper than cure at a later stage, after the damage is done. Sharing the world-wide concern for environment, India has initiated a number of measures.

(i) Constitutional: India is one of the few countries in the world, where the need for environmental preservation is recognised and stressed in the Constitution itself. Article 48 (A) of the Directive Principles of the Constitution, for instance, makes it the responsibility of the State "to protect and improve the environment and to safeguard the forests and wild life of the country." Similarly, Article 51A (g) makes it a duty of the citizens "to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures." Another relevant

provision in Article 253 which empowers the Central Parliament to enact legislation on any topic covered by an international agreement to which India is a party.

(ii) Environment and economic planning: This concern for safeguarding our envirnment is kept in view in our economic planning also. In all the successful Five-Year Plans, it is recognised that economic planning should entail a thorough appraisal of the objectives of development so as to link them explicitly with social and human needs of health, shelter, clean air, water and generally good environment. It is similarly appreciated that the costs for prevention of pollution will have to be part of the project investment.

The current Sixth Plan document clearly emphasises that ".....plan will ensure that projects and programmes which are likely to cause unacceptable environmental damage are not taken up....."

Population policy

Aware of the imperative need to check the spiralling population, Government of India have announced a National Population policy. Besides "Family Welfare Schemes," due stress is laid on education of the masses about the need to limit the size of the family. In matters of determination of quantum of Central assistance to States, the latter's performance in "Family Welfare Schemes" is included as one of the main criteria. Emphasis is now more on persuasion than on compulsion.

National Forests policy

Presently, about 23% of the total land area comes under the category of forests. A legislative framework does exist to protect the forests from destruction. In addition, recently, "Forests" and "Protection of wild animals and birds" have been included in the Concurrent List of our Constitution (Items 17A and 17B of the Concurrent List). The implications of this would be that while both the Centre and the States would have powers to legislate on these topics, the Central legisla-

tion would prevail in the case of conflict of provisions between the two legislations.

There is also a proposal to revise the National Forest policy to make it more effective. One of the suggestions made in this regard is that while a minimum percentage of forests should be fixed for the whole of land area, a similar but higher percentage should be specified for hilly areas and strictly adhered to.

Industrial policy

Proper siting is the first step to minimise environmental degradation due to industries. As concentration of industries in metropolitan cities has led to a rapid deterioration in the living conditions of the working classes, Government of India have decided that no more licences would be issued to new industrial units within certain limits of large metropolitan cities have a population of over one million and urban areas with a population of over ½ million. Prior environmental assessment of projects before their sanction is also receiving attention. For instance, under the Registration and Licensing of Industrial Undertaking Rules, it is obligatory that before any new industrial licence is issued, the enterpreneurs should indicate clearly the adverse environmental effects of the projects and how they propose to tackle the same. In addition, the projects formulated by various agencies are referred to NCEPC for scrutiny from environmental angle. NCEPC has set up Environmental Appraisal Committees for the scrutiny of such projects.

Institutional arrangements

In recognition of the importance of environmental protection, Government of India have set up a National Committee on Environmental Plann ing and Coordination (NCEPC) with very wide terms of reference. This broad-based multi-disciplinary body is to review, formulate and promote policies and programmes covering development projects, physical planning, legislation, administrative procedures research, etc. This Committee has played an important role in formulating legislation on environmental protection, in developing guidelines

for different sectors of environment to ensure that environmental considerations are taken into account in development planning. It also promotes research on various sectors of environment. At State level, there are corresponding State Environmental Committees which are expected to play a similar role within their jurisdictions.

Legislative framework

Conscious efforts are being made to build up requisite legislative framework for purposes of environmental protection. As on today, there are legislations in the following sectors.

1. Preservation of water quality.
2. Protection of wild life.
3. Preservation of trees and parks.
4. Land use planning.
5. Clearance and improvement of slums.
6. Control of insecticides.
7. Protection of cultural property.
8. Control of marine pollution.
9. Safe disposal of radio-active wastes.
10. Protection against environmental degradation due to mining.

A bill for Preservation of Air Quality has been recently passed by the Parliament.

Employment and Environment

Generally speaking, developing countries especially in South East Asia are marked by excessive population and a high level of unemployment. Such high incidence of unemployment has a snow-balling effect leading to progressive environmental deterioration. Without corresponding output, the resources would get consumed fast. Faced with abject poverty and not sure of their next meal, it is no wonder that these unemployed cannot care less for the environment around them. Any talk of spreading environmental awareness among them would be nothing beyond empty talk.

At the same time, all these welfare states are doing their very best to improve the lot of these common masses. It is possible to formulate appropriate development programmes which, while fully serving these objectives of the Governments would also improve the environment in the process.

Naturally, in formulating such programmes, the local conditions will have to be kept in view. Any wholesale adoption of technology from any other country could only be next to suicidal. Some of the scheme that commend themselves for consideration are:—

Rural Development works

It is common knowledge that our rural areas lack the minimum amenities of life. Talking of India, nearly 33% of villages have been identified as problem areas, without any satisfactory protected drinking water supply. It is also reported that only 7% of population is served by any drainage system. There are many other areas where position calls for urgent attention.

These areas can be usefully tackled. In India, a new programme of "Integrated Rural Development" has been started in selected 20 Districts. All requirements of villages—as, roads, water supply, power supply, education, health care, banking, improved agricultural practices, are sought to be covered under this programme.

Afforestation

Loss of forest is relentlessly lamented by all. Particulars of millions of hectares of forests thus lost are reeled off. Could we pause to visualise the stupendous benefits possible, if in a country with 600 million population, each member plants (and looks after) 2 plants per yeas? The employment opportunities and the restoration of ecological balance are worth all efforts.

Fuel needs

In India, the yearly requirement of firewood to meet the day-to-day needs is placed at more than 100 million tonnes.

Bio-gas plants are yet to be extensively installed. Large scale construction of these plants has obvious dividends.

Village and Small Scale Industries

While providing employment to the people, care should be taken to import a productive skill which will help the people with a continuing employment. Village and cottage industries, small scale industries fill the bill in this regard. In formulating these schemes, environmental considerations should not be lost sight of.

Small Farmers' and Marginal Farmers' development would be yet another field which could profitably taken up.

The above fields of employment are mentioned only by way of illustration. These will have to be suitably evolved and developed, depending on the requirements of each country. Carefully planned, they will not only help raise the standard of living of the people, but, in the process, positively held improve our general environment.

7

Marine and Coastal Environment Management

R. Sen Gupta

Earth and the Oceans

EARTH IS THE water planet. Since the crust solidified, water has been extracted from the earths interior to collect in depressions. Nearly 71% of the earth's surface is overlain by a blanket of water, averaging 3,730 metres deep. At any instant only a small fraction of the earth's water is present in the atmosphere, or retained by the land in lakes, or locked in glaciers and ice caps. Nearly all the water remains in the oceans.

Most of the earth's population lives within a few hundred kilometres of the ocean shore. For these people the ocean serves as a recreational area, food source, and as a highway for commerce. Even to those living far from the ocean, its influence on daily life is great. Not only does the ocean supply the water necessary for life, but it also stores and then releases much of the solar energy that powers earth's atmospheric circulation, causing our weather. In short, ours is a water-conditioned existence, and by studying the ocean we can learn about a dominant feature of our environment.

Considering the earth's surface (510 million square kilometres) the ocean covers 361 million square kilometres or 70.8%. With a volume of 1368×10^{18} litres the mass of the

world oceans amounts to 1.419×10^{18} metric tonnes or only 0.24% of the total mass of the earth (591×10^{18} metric tonnes).

TABLE I

Earth and the Oceans

Area of the earth	510×10^{6}*km^2
Area of the Oceans	$361 \times 10^{6} km^2$ (70.8% of the earth)
Mass of the earth	591×10^{18} metric tonnes
Mass of the Oceans	1.419×10^{18} metric tonnes
Volume of the Oceans	1368×10^{15} litres
Area of Bay of Bengal and Arabian Sea	$10.312 \times 10^{6} km^2$ (2.9% of all oceans)
Land area of India	$3.276 \times 10^{6} km^2$ (31.8 of the seas around India).

*See Appeddix for discussion of exponential notation.

Of the total available water 97.2% is contained in the oceans. Out of the remaining 2.8%, most is in the solid form. The amount of water actually available above the ground and in the atmosphore to the 4.3. billion people of our globe is only 0.031% of the total water resources.

The ocean is an ancient feature of the earth's surface. The earth is thought to have formed 4.5 billion years ago and the oceans have probably existed for 3 billion years. But the boundaries between land and water have probably changed

TABLE II

Mass and Distribution of Hydrosphere

	Mass (10^{18} *tonnes)*	*Relative abundance* (%)
Sea Water	1419	86.445
Lakes, rivers	0.5	0.03
Continental ice	22	1.34
Water vapour in atmosphere	0.013	0.001
Water in sediments	177	10.784
Water in sedimentary rocks	23	1.4
	1641.513	100

location many times. This is because of the melting of glaciers after an ice age. Much of the new shallow areas of the oceans were once dry land. It is believed that about 20,000 years ago the sea was 130 m below its present level. Asia and North America were then connected together by a land bridge, now covered by the shallow Bering and Chukchi seas.

This then is, in short, the ocean which is called the common heritage of mankind. The zone of the oceans which is of maximum use to us to day is the uppermost 100 metres, although the average depth is 3730 m. This forms only about 25% of the total area of the oceans and 1.8% of their volume. To day more than 50% of the world's fish catch is obtained from the coastal area of the continents which is only 0.01% of the total surface area of the oceans.

The Seas around India

The total land area of India is $3.276 \times 10^6 km^2$ which is only 0.64% of the earth's surface. The area occupied by the Bay of Bengal and the Arabian Sea is $10.312 \times 10^6 km^2$ which is 2.9% of the area of all the oceans. Thus, we can see that the marine area around India is about 3 times its land area. But the whole marine area does not belong to India alone, as every country along the sea has the area from its shore to a distance of 200 nautical miles (370 km) belonging to it where it has got exclusive rights to explore and exploit the living (e.g. fishes etc) and non-living (e.g. minerals, oil) resources. This area is called the exclusive economic zone (EEZ) of each country. However, ships of other countries are allowed to sail along this area. This kind of sailing is called innocent passage. The exclusive economic zone of India has an area of $2.015 \times 10^6 km^2$ which is 61.5% of the total land area of our country.

Average annual rainfall over the Indian sub-continent is $3.4 \times 10^{12} m^3$. The same over the Bay of Bengal and the Arabian Sea is $6.5 \times 10^{12} m^3$ and $6.1 \times 10^{12} m^3$ respectively. Thus, the seas around India receive about 4 times as much rainfall as on land. The total annual rainfall over all the oceans is $324 \times 10^{12} m^3$. This would mean that the seas around India receives 3.9% of the rainfall over all the ocean while they occupy 2.9% of the total marine area. While the rainfall over the sea is added entirely to sea water only a fraction of the rains on land reach the sea through percolation of ground water and river runoff.

India has a coastline of about $6000 km^2$ in which many rivers flowing, through the country discharge about $1645 km^3$ of freshwater every year. Of this quantity of fresh water, nearly 75% is added to the Bay of Bengal. About 1.4 million tonnes of fish is harvested per year from the seas around India and due to increasing fishing effort the fish catch is increased at the rate of about 10% every year, thus doubling every 10 years.

Present State of Pollution in the Seas Around India

The population of India is around 620 million. Nearly 155 million, or roughly about 25% of the total population, live in coastal areas. The rate of generation of domestic sewage and wastes in metropolitan cities of India is 120 litres per person per day. It can conservatively be assumed that this rate for coastal population can be half of that for metropolitan cities, that is, 60 litres per person per day. Calculating on this basis the total annual addition from this source comes to about 35km³.

Industries located along the coast also discharge their effluents into the sea. It has been calculated that in India of all the additions of sewage and effluents to the sea about 10% is of industrial origin. This means that another 3.5 km³ of effluents is added every year to the sea from the industries located along the coast. As an example, Bomboy City discharges every year 0.39 km³ of sewage (1060 million litres per day) and 0.085 km³ of effluents (231 million litres per day) to the sea and creeks around. Calculating at the rate of 1.7 kg per person per day, the coastal population of India would generate about 96 million tonnes of solid waste or garbage per year, a considerable portion of which ultimately finds its way into the sea.

It has been assumed that about 5% of all the wastes discharged into the rivers finally reaches the sea. Industries in the delta region of river Ganga, having an annual runoff of 370 km³, discharge 0.41 km³ of wastes into it every year. Using this rate for the total annual river runoff of 1645 km³ would give an addition of 1.82 km³ of sewage and effluents to the Indian rivers every year. 5% of this or roughly 0.1 km³ goes to the sea.

The production of pesticides in India is, on an average, 50,000 tonnes per year. Similarly, about 125,000 tonnes of synthetic detergents (washing powder, liquid soap etc) are being used annually in our country. It is commonly believed that about 25% of these will finally reach the sea. This would

TABLE III

Population and Related Data for India and Some Estimates of Pollutants Entering the Sea Around India.

Population	620 million
Coastal Population	155 million
Land area	$3.276 \times 10^6 km^2$
Exclusive Economic Zone	$2.015 \times 10^6 km^2$
River runoff (annual)	$1645\ km^3$
Rainfall (per year on land)	$3.4 \times 10^{13} m^3$
Rainfall (per year on Bay of Bengal)	$6.5 \times 10^{12} m^3$
Rainfall (per year on Arabian Sea)	$6.1 \times 10^{12} m^3$
Domestic sewage added to the sea by coastal population (per year)	$35\ km^3$
Industrial effluents added to the sea by coastal industries (per year)	$3.5\ km^3$
Industrial effluents added to the sea through river runoff (per year)	$0.1\ km^3$
Solid waste generated by coastal population (per year)	96×10^6 tonnes
Pesticides manufactured per year	50,000 tonnes
Synthetic detergents manufactured per year	125 000 tonnes
Oil transported in 1978 across the Arabian Sea	975×10^6 tonnes
To Western Hemisphere	652×10^6 tonnes
To For East and Japan	323×10^6 tonnes
Tar deposition on beaches from Kutch to Kerala 1975	1000 tonnes
1976	750 tonnes

mean that annual addition of pesticides and detergents to our marine areas would be about 12,500 and 31,250 tonnes respectively.

Crude oil and its products from countries bordering the Arabian Gulf (Persian Gulf) are transported across the Arabian Sea along two tanker routes. One of these oil tanker route go to countries in the Western Hemisphere via Mozambique Channel and round South Africa. The other route goes to Far Eastern countries and Japan along the Indian EEZ, round Sri Lanka and then across the southern Bay of Bengal to the Malacca Strait. The second oil tanker route is of much concern to India.

In 1978, the total marine transport of oil and its products in the world was 1681 million tonnes. Of this, 975 million tonnes or 58% of the total, were shipped along the two oil tanker routes across the Arabian Sea. The volume transported along the second oil tanker route was 223 million tonnes. As a result of oil spill and bilge washings (cleaning of empty tanks by sea water) on this tanker route 750-1000 tonnes of oily residues (tar balls) are deposited on the beaches on the West Coast of India during the south-west monsoon months (June-September) every year. Water at the surface of the Arabian Sea flows towards the Indian west coast only during June to September while during the rest of the year it flows away from our west coast and that is why tar balls are deposited only during the south-west monsoon months.

Hazards of Pollutants

When a pollutant is released to the sea it may undergo transformation by different chemical and bioiogical processes. The end-product of these processes may be sometimes less and sometimes more hazardous than the original substance. There are certain pollutants which do not undergo any change in the marine environment and are called persistent pollutants.

Another process that makes the pollutant more dangerous is biomagnification. Pollutants, such as some of the

heavy metals, are assimilated by single-cell organisms in the sea called phytoplankton which are of algal origin. These form the food for zooplankton, which are of animal origin. Zooplankton is eaten by small fishes, some of which form the food for big fishes and other marine animals like sharks etc. An example of biomagnification is mercury, which occurs in water at annogram level (10^{-9}g) while in fishes like tuna it is at milligram level (10^{-3}g). This means that mercury in marine environment can be biomagnified one million times before it reaches man through his food. The same process takes place for most of the pollutants.

One of the pollutants added to the sea in large quantities by man is his own waste. Requirement of drinking water for every person is about 2-3 litres per day. But the actual volume added to the sea as waste is very often a hundred times greater than this quantity. Human waste contains a very high proportion of organic polyphosphates used in synthetic detergents. Organic nitrogen content of the sewage is also fairly high. Sewage contains about 2-5 times as much phosphorus as nitrogen by weight. When released into a marine environment, with poor flushing and slow rate of water exchang, the extra quantities of organic phosphorus and nitrogen are converted to their easily assimilable organic forms by degradation by bacteria at the expense of the oxygen dissolved in water. The inorganic salts serve as nutrients to unicellular algae (phytoplankton) leading to dense algal blooms. About 10% of this algal production is consumed by zooplankton and fishes and another 10% can settle to the bottam undecomposed. The remaining 80% decay and deplete the dissolved oxygen in water and very often produce toxic hydrogen sulphide releasing their inorganic salts to the water. When new water flows into the basin, this nutrient-rich water from the bottom is flushed upwards causing once again dense algal blooms at the surface. This process is known as 'eutrophication' and goes on repeating almost by itself. Sewage also contains large quantities of harmful bacteria like the coliforms and the pathogens, and many different forms of disease-carrying viruses. When the concentrations of these microbes

in the water exceed a certain limit the water becomes unfit for bathing, swimming and other recreational purposes.

Petroleum hydrocarbons in the sea bed (fossil fuel) occur as an intermediate stage in their geologic transformation to methane, carbon dioxide etc. (natural gas). This has always entered the sea from natural seepages. Petroleum-type hydrocarbons also occur naturally in some marine organisms. Due to increased transport of oil across the oceans oil spills have become one of the major sources of pollutant in the marine environment. Immediate effect of oil spills are mortality of sea birds. Oils dissolve their protective coating on the wings of the birds as a result of which they become weather-bitten and die. Oil films block the sensory organs in certain marine crustacea (prawns etc.) and thereby disable them from finding food and escaping predators. It also inhibits the reproductivity of egg-ladened lobsters. Oils visibly damage molluscs, oysters and all other bottom-dwelling organisms rendering them unfit for human consumption.

Concentration of several toxic heavy metals in certain marine areas of the world have increased by about a hundred times during the last 15-20 years. For example, lead tetraethyl added to the petrol as anti-knock additives in automobiles are carried by air in the form of exhaust gases to the surface waters of the sea. This process alone has increased the concentration of lead in the surface waters of the oceans 500 times. Increased industrial use of mercury has resulted in the now world famous "Minamata disease" in Japan caused by human consumption of fishes which heavily concentrated this toxic metal in their bodies. This disease has resulted in births of deformed and mentally retarded children. Cadmium poisoning through concentration by aquatic animals can result in damage to kidneys, protein in urine and eroding of calcium in bones giving rise to the disease "Itai-itai". Several other metals, like copper, zinc, arsenic, have been observed to be accumulated in plankton, fish and bivalves. The damaging effect of most of these are slow and often irreversible and can be first observed in the second generation only.

DDT, PCB etc. belong to the category of pollutants called polychlorinated hydrocarbons. They are perstent pollutants, that means when released to marine environment they do not undergo any change in their composition. Both DDT and PCB are known to be accumulated in certain plankton, crustaceans, molluscs and fishes. Birds feeding on such contaminated animals have been observed to lay eggs with very thin shells which never hatch. This has resulted in progressive decline of certain marine birds effecting the marine avian life.

Man is striving to find out alternate sources of energy, due to the gradual but steady decline in the reserves of non-renewable sources like oil, coal etc. Examples are nuclear and thermal power stations. The amount of heat generated by the cooling water of this process and released to the seas can cause extensive damage to marine flora and fauna. Radioactive wastes from nuclear power plants may accidentally get released to the seas and can cause very severe damages.

However, in areas where tides occur twice a day raising or lowering the sea level by several metres, the effect of discharge of pollutants may not be very pronounced, as tides generally flush out the areas. The tidal range along the Indian coast varies from about 1 metre at the southernmost tip of the country to about 8-9 metres in the Gulf of Cambay and the Sunderbans area.

Control of Pollution (Environmental Management)

Man has realised the hazards the pollution, created by himself, can do to his own environment. Therefore, he is trying his best at the same time to reduce the dangers to himself and to his future generation. One of the steps, applied at the present time, is to treat the sewage and sewage and effluents in order to make them less harmful or totally harmless. Laws for the control of environmental pollution exist in almost all the countries of the world and they are either modified or updated from time to time to suit the changing situations.

Sewage is often released into the sea after preliminary treatment (mostly removal of solids and floating material) and in some places after secondary treatment (mostly removal of organic and toxic material). If it is properly subjected to secondary treatment, the resulting water will contain mostly phosphorus and nitrogen compounds, which could be profitably used for irrigation and fish culture. In U.S.A. secondary treated sewage has been successfully utilized for polyculture of phytoplankton, oysters, fish, lobsters and seaweeds. The resulting effluent, thus, become completely free from nutrient salts rendering it harmless before release to the seas. In India experiments are going on to produce more food using treated domestic sewage. In China water obtained after the secondary treatment of sewage is used in agriculture.

Oil spills can be tackled by several physical and chemical means. The physical means consist of checking the oil from spreading and recovering the oily water for further separation. Chemical means include the use of dispersants, which have been tested and confirmed as non-toxic, to complex the oil and then to sink it to the bottom or to recover the complexed material. Oil can also be degraded by spreading selected bacteria over it.

In India problems of marine pollution have not yet turned to be very serious. But in some areas, like Bombay, it has become serious increasing the concentration of phosphorus in coastal waters and rendering fishes from some of the creeks inedible due to the increased concentration of mercury in them.

The most important aspect of environmental management is regular monitoring of pollutants. Concentrations of dangerous chemicals should be measured at regular intervals and whenever they reach the upper safe limit immediate warning has to be issued and suitable steps should be taken to prevent the damage.

Qualitative monitoring of the environment can, perhaps, be profitably included in the science study courses of schools.

This will make the students interested in environmental studies and can succeed in making them motivated in the long run. It will be very useful if the students can carry out experiments using samples of water, soil, flora, fauna etc. collected from the surroundings of the school as well as samples collected from surrounding villages. This should not require any significant change in curricula but only a change in attitude of the teaching staff or educational authorities. This will also provide base line data over wide areas and the people living in that area will be better aware of their surroundings. This collection of baseline data is important for planning. For example the data on wind velocity and direction in the rural areas will be useful for decision on location of wind powered mills and for locating the sewage treatment facilities etc. Similarly information of solar radiation intensity over different periods of the year will be valuable for setting up of solar energy cells and other future applications.

The parameters those can be measured, by including them in the practical course of the school students studying science, are: pH, temperature, conductivity, dissolved oxygen, oxidation-reduction potential, turbidity, humidity, wind velocity and direction, solar radiation intensity etc. Instruments for all these measurements are simple and available in India at moderate costs. An example and approximate cost of a set of instruments, required to monitor these environmental parameters is presented in Table IV. Though, mentioned in this article this set of instruments would be useful anywhere in our country. Funds for all these can, perhaps, be applied for either to University Grants Commission or NCERT who should also undertake the responsibility of coordinating this kind of studies at the schools so that the information obtained can be suitable and properly utilised.

TABLE IV

Instruments and Costs of a simple monitoring set*

Parameter	*Suggested method/instrument*	*Range & accuracy*	*Representative Cost*
Temperature	Silicon diode/Thermistor	0-50°C, ±0.5°C	Rs. 5000/- (e.g. CSIO water analysis kit).
pH	pH meter/electrodes	0-14pH, ±0.1pH	
Conductivity	Conductivity bridge	1 mho to 1 micromho, ±3%	
Dissolved Oxygen	Membrane probe/DO monitor	0-20 ppm, ±1 ppm	
Oxidation reduction potential	ORP monitor/pH meter	±1000 mV	
Turbidity	Comparison method	—	—
Humidity	Hygrometer	—	Rs. 100/-
Wind velocity and direction	Anemometer and wind vane	Velocity threshold 1 km/hr, Wind direction ±5°	Rs. 1500/-
Solar radiation intensity	Sunshine meter		Rs. 4000/-
Bacteriological investigation	Microscope	x100 magnification	Rs. 1000/-
Dust measurements	Dust collectors		Rs. 100/-
		TOTAL (approx.)	Rs. 12000/-

*Reproduced from "Report of the Panel on Environmental Monitoring Instrumentation, Electronics Commission, Government of India, December, 1976."

79

APPENDIX

Exponential Notation and Metric System

Exponential Notation

In discussing the earth or its oceans, we must frequently use very large numbers. To simplify writing, reading and understanding such numbers, we employ exponential notation which indicates how many zeroes are in our number. Commonly used large numbers may be written as follows:

$10^2 = 100$	One hundred
$10^3 = 1000$	One thousand
$10^6 = 1,000,000$	One million
$10^9 = 1,000,000,000$	One billion
$10^{12} = 1,000,000,000,000$	One million million
$10^{18} = 1,000,000,000,000,000,000$	One billion billion

(Compare: $10^5 = 100,000$ One lakh; $10^7 = 100,000,000$ One crore)

Length

1 kilometre (km)	$= 10^3$ metres
1 metre (m)	$= 10^2$ centimetres
1 centimetre (Cm)	$= 10$ millimetres (mm)

Area

1 square kilometre $(km)^2$	$= 10^6$ square metres
1 square metre (m^2)	$= 10^4$ square centimetres (Cm^2)

Volume

1 Cubic kilometre (km^3)	$= 10^9$ cubic metres
1 Cubic metre (m^3)	$= 10^6$ Cubic centimetres $= 10^3$ litres
1 litre (l)	$= 10^3$ cubic centimetres (Cm^3)

Mass

1 metric tonne	$= 10^3$ kilograms
1 kilogram (Kg)	$= 10^3$ grams (g)

8

Environmental Problems due to Mining in the Jharia Coalfield

S.P. Banerjee

Introduction

JHARIA COALFIELD is the most important source of coking coal and the only source of prime coking coal in the country. The coalfield is situated about 260 km north west of Calcutta in the district of Dhanbad, Bihar between the latitudes 23°-39' to 23°-48' and longitudes 86°11' to 86°27'. It covers an area of 480 square kilometers and contains a reserve of approximately 13000 million tonnes of coal. The field is roughly elliptical or sickle-shaped and the river Damodar flows through the southern edge of the coalfield.

Coal mining started in this region in 1890 and a large number of companies obtained lease holds in the coalfield. Some 384 mines were operating in the coalfield in the early 1970s producing approximately 18 million tonnes of coal per year. The coking coal mines were taken over by the Government in October, 1971 and the non-coking coal mines in January 1973, so that as many as 83 mines in the coalfield (leaving only 5 mines belong to TISCO and 2 mines belonging to IISCO) are operated now by the public sector organisation, Bharat Coking Coal Ltd., a subsidiary of Coal India Ltd. Operations in Jharia coalfield may, thus for all practical

purposes may be considered as the operations of BCC Ltd. An ambitious reconstruction programme has been drawn up by BCCL for improving the mining methods and increasing the output of coal from the coalfield. Many years of intensive mining has created large scale environmental problems in the coalfield. The implementation of the reconstruction programme will bring further changes in the environment. It is proposed to discuss the environmental problems in JCF created by mining under the four heads of land damage, water pollution, atmospheric pollution and human settlement. A brief resume of the geology, pattern of coal production and consumption, and the reconstruction programme of the coalfield is included in the beginning to give a perspective of the environmental problems of the present day as well as that of the future.

Geology and Coal reserve

A total of 28 major coal seams occur in two geological horizons, known as the Barakar measures and the Raniganj measures. Barakar measures are the older formation lying at the bottom of the coal basin and contain 19 major seams. Of these, the first mine, numbered O to VIII are either of the medium coking type or of weakly coking type, recently designated as new coking coal. Seams IX to XVIII are of the prime coking variety. Raniganj measures are younger in age and occur only over a small part i.e. 55 sq km of the coal basin. These contain 9 seams of medium coking type of which only 5 are workable. Some important parameters of the mines belonging to BCCL are as follows:

Total area of Jharia coalfield	455 sq km
Area belonging to BCCL (excluding 32 sq km in Raniganj field)	223 sq km
No. of mines (excluding 8 in Raniganj field)	83
Average area per mine	2.7 sq km

Intensity of exploitation	Approx 260 tpd/sq km
Reserves:—	
(a) Coking coal	About 6000 Mt
(b) Non-coking & new coking coal	About 7000 Mt
(c) Proved reserves	40%
(d) Indicated reserves	26%
(e) Inferred reserves	34%

Production, consumption and reconstruction Programme

The output from BCCL mines has varied from 20 to 21 million tonnes during the last 5 years. This figure contains the output from the Jharia field mines as well as approximately 1.2 million tonnes obtained from the Chanch-Victoria group of mines in Raniganj coalfield. The output obtained from the TISCO and IISCO Collieries in the Jharia coalfield is, however, not included in the above figure. The production from the BCCL mines in million tonnes for the period 1974-75 to 1977-78[1] is given below:

	1974-75	*1975-76*	*1976-77*	*1977-78*
Prime coking	9.13	10.89	11.91	11.43
Medium coking	1.00	1.09	1.16	1.28
All coals which have been declared as coking but are used for non-metallurgical purposes	2.14	5.01	4.78	4.53
Non coking	5.47	3.10	2.83	2.97
Total	17.74	20.09	20.68	20.21

Nearly three fifths of the coal produced in the Jharia coalfield is used by the steel plants. Over 50% of the production is sent to coal washeries where clean coal, middlings and rejects are produced. Whereas the clean coal is used for metallurgical purposes, the middlings are used for power generation. The other major consumers are the power stations (14%), brick kilns (11%), railways (3%), and soft and hard coke manufacturing (11%). The actual despatches of BCCL coal to different categories of consumers for the year 1974-75 to 1976-77 are as follows[2]

	1974-75	*1975-76*	*1976-77*
	(all figures in Mt)		
Coking coal			
Steel	1.515	1.805	2.032
Washery	7.115	8.259	8.995
(Sub total)	(8.63)	(10.064)	(11.027)
Non-coking coal			
Loco	0.739	0.719	0.537
Power houses	2.564	2.664	2.452
BRK	1.781	1.683	1.928
Hard coke	1.239	0.943	0.785
Soft coke	1.198	1.139	1.235
Total despatch	16.151	17.212	17.964

The projected production from the Jharia coalfield is related to the demand for coking coal which will progressively go up with an expansion of the steel sector. While the demand for prime coking coal was 14.3 million tonnes in 1978-79, it is expected to go up to 24.5 million tonnes in 1987-88. The production programme drawn up for Jharia field in August 1978 envisages a doubling of production from 20.21 million tonnes produced in 1977-78 to 40.1 million tonnes in 1987-88[3], and by the turn of the century, the output will further go up to approximately 50 million tonnes per annum. As the reconstruction plan gains momentum, there will be major changes in the pattern of mining, with a higher emphasis on

large scale mechanised opencast mining and concentrated production from a few integrated underground mines. Naturally the environmental impact of mining will undergo great changes and it is proposed to examine the environmental problems existing to-day as well as the problems likely to arise in the future, under the headings of damage to land, water pollution, air pollution and human settlements in the coalfield.

Land Damage

Jharia coalfield is located in a dry and barren zone with rocky and gritty surface devoid of much alluvium. Agriculture is carried out only in patches in the low lying valleys and even there the yield is poor. Sporadic vegetation of Palas, Mulberry and Mahua trees and bushes of Lantena and Bon tulsi dot the bare surface. Damage to this land has been caused by opencast mining, due to subsidence from underground workings and from fires caused by mining. A lot of land is also used by the structures and buildings needed for the mines and the ancillary activities.

Opencast Mining

Small scale opencast mining has been carried out in the Jharia coalfield for many decades, mainly by manual means and confined to shallow depths in the outcrop zones of the coal seams. During the time of nationalisation of the coking coal mines, a total of 36 opencoat mines were each producing an average of 200 tonnes per day. The share of production between the opencast and underground mines of BCCL in recent years has been as follows:

	1974-75	*1975-76*	*1976-77*	*1977-78*
Production from opencast (Mt)	2.1	3.06	2.53	2.73
Production from underground (Mt)	15.64	17.03	18.15	17.48
Total BCCL Production (Mt)	17.74	20.09	20.68	20.21

The percentage of opencast production has gone up since then to about 18% in 1979-80 and will be progressively increased in the coming decade to 35% in 1987-88. According to the reconstruction plan prepared recently in collaboration with Kopex of Poland, the entire outcrop region of Jharia coalfield will be worked by opencast method. The area has been divided into 9 major opencast blocks, with output from each varying between 6 to 10 million tonnes.

Before commencement of surface mining, the ground is cleared of vegetation, the soil removed and the void created by removal of the mineral is partly filled with broken overburden rock and a part is left as void. The disfigurement of land is greater the greater the depth of the open pit. The water table is also disturbed for a considerable area. The projected opencast mines in Jharia coalfield will go up to a depth of 380m in one mine and up to 300m in others. These figures are many times more than the maximum depth of any of the existing opencast mines in the coalfield. Jharia coalfield has a scarcity of top soil and reclamation of the land would need obtaining the same from a distance, thus increasing the cost of reclamation. Annual rainfall is of the order of 1400 mm, which may be considered sufficient for conduct of reclamation measures. No effort of land reclamation of opencast sites in the Jharia coalfield has been taken so far. A small scale R & D trial with expected financial support of the Dept. of Science & Technology, Govt of India has been initiated in an old quarry site by an interdisciplinary team of which the present author is also a member. Considering the poor quality of original land surface in Jharia coalfield, the author believes that the restored land in Jharia coalfield can be made better than the original for agricultural forestry or park land purposes.

Land damage by subsidence

Extraction of a coal seam underground causes land damage by lowering of the surface and breakage of the strata above the extracted area. It has been known for a long time that not only the area lying vertically above the area of extraction but also surrounding areas for a considerable

distance lying over unworked portions of the coal seams get affected by minir g subsidence. A line joining the rib side edge of a working to a corresponding point on the surface beyond which no measurable movement occurs is known as the limit line and the angle between the limit line and the vertical is known as the angle of draw. The value of the angle of draw is small for strong strata such as sandstone and large for soft strata such as alluvium. Jharia coalfield abounds with strong strata and the angle of draw may be taken to lie between 17° to 30° in the strike direction.

It is not only the vertical lowering that causes damage, but the tilting of the surface and the tensile and compressive strains associated with subsidence that cause maximum damage to a structure in a mining area. The high concentration of coal seams in the strata and the absence of alluvium cover have made the subsidence effects very prominent in Jharia coalfield. "Large cracks have appeared in many mined out areas and buildings have cracked or collapsed, ropeways and powerline trestles have got tilted, roads got damaged and sometimes even life has been endangered. A classic case of a large scale subsidence danger in Jharia coalfield occurred some years ago in North Kujama Colliery. An area of about 200 m x 150 m standing on pillars made in the 14 m thick X seam lying at a depth of approximately 21 m suddenly collapsed in the night of March 30, 1974. Average subsidence observed at the surface was 2.4 m. The District Board road from Jharia to Baliapur passing through this area also sank by an average of 1.2 to 1.6 meters. Two persons were buried asleep and died under the debris of a two storied building that collapsed. Fortunately, most people came out of their dwellings due to the rumbling sound that preceded the subsidence and more damage to life was avoided.

Many cases of delayed subsidence has been reported in the coalfield. Mining has been done a longtime past but the ground has not settled. Subsequently, working of a lower seam or a contiguous area has caused sudden breakage of the strata. There have been subsidence damage to railway track, river beds and roads. An estimate of area affected by

subsidence has been given in the Project Black Diamond as 31.23 sq km. The Planning Commisson's Committee on coal mine fires and mine subsidence in 1966 estimated that 32.26 sq km of area was damaged by subsidence of a total coal bearing area of 392.57 sq km in Bihar.

With the reconstruction programme of Jharia coalfield going in full swing, underground mining will be carried out mostly at depths of over 200 m or so. Subsidence due to deep workings is generally more evenly spread out than for shallow workings. Therefore, environmental damage due to subsidence is expected to be less severe in the future from this count. On the other hand lack of availability of sand and other stowing material as well as the need to improve productivity would necessitate the adoption of caving method in a larger scale, which may increase the severity of damage due to subsidence.

Mine fires

Coal, like other carbonaceous material undergoes auto-oxidation when exposed to air. If the condition of confinement is such that the heat produced by auto exidation is not fully dissipated, the temperature rises and ultimately the coal catches fire. In mining, even with the best of efforts, some amount of coal is left in the goaved out area. Unless the area is completely sealed to cut off the supply of oxygen, the left out coal may catch fire. Development of subsidence cracks provides a path for supply of oxygen. A coal seam may also catch fire at its outcrop region, particularly at quarry edge if due to carelessness some hot material is dumped against the coal face. A fire, once started in a coal seam, gradually starts spreading in all direction. Jharia coalfield has been dotted with numerous fires which have not only caused loss of a large amount of coal but also have damaged land over a vast stretch of the coalfield, have been a major source of air pollution and have disrupted the road and other communication network in the coalfield. Till today there are 110 fires reported in the JCF, out of which 70 are in active state. On a broad estimate, about 34 Mt of coking coal has been lost and about 46 Mt of coal is locked

up due to these fires[4]. The fires belch out smoke and tar causing air pollution in its vicinity. Trenching and blanketting operation are undertaken to control the fire, which disfigures the land. Projects to control and extinguish some of the large fires have been formulated by BCCL and a few of these, such as the Rajapur and Jogta fire fighting projects are now under implementation.

Blocking of land by Refuse heaps

Along with coal, a lot of carbonaceous shale and other stony material is mined which is separated from the coal in the cleaning plants, washeries or railway sidings. With years of accumulation, many of the refuse heaps have assumed great heights. Some of these heaps contain inferior coal and carbonaceous shale which has caught fire and has been smouldering for a considerable period. There are also refuse heaps from boiler ash, waste rock from mines and junks from broken and disused machines. Some of the old refuse are utilised today in road making and stowing purposes. An experimental scheme for crushed stones towing is in its final stage of commissioning. Successful use of these refuse heaps will greatly improve the landscape of the coalfield and release valuable land near the mine sites.

Water Pollution

The most familiar water pollution problem due to mining results from drainage of acid mine water into the water courses. This problem is not at all acute in Jharia coalfield where the majority of the mines do not have acid water problem. However, water pollution result from the working of the ancillary industries particularly coal washeries and coke oven plants. At present Jharia coalfield has six washeries and only about 45 per cent of the coal produced is washed. In future all the coal produced will be washed. A total of 12 new washeries have been proposed in the Jharia reconstruction programme so that total washing capacity will be of the order of 50.6 miliion tonnes per year after 1995-96. The effluent from the existing washeries carry a lot of fine coal in suspension and the water in river Damodar beyond the out-

flow of Dugda and the other washeries often becomes black in colour from this cause. The future washeries would be designed to have a closed water circuit and thus there will be less of water pollution from coal washing even though the total capacity of the washing plants would rise by 5 times. Nearly 1.25 million tonne of soft coke and 0.7 million tonne of hard coke is produced by BCCL every year and effluents from these also add to the water pollution. Streams in Jharia field—Jamunia, Khudia, Katri, Bansjore and Kari jore are all seasonal. Some of them dry up in the summer over parts. Some of the smaller streams fall in into these major drainage channels had to be diverted in the past to permit recovery of underlying coal reserves. The development of the large open-cast mines in the rise side of the coalfield during the reconstruction phase would need large scale effort for diversion of these drainage channels.

Besides the coal mines and the washeries, Jharia field is fringed by the giant Bokaro Steel Plant, the Chandrapura thermal power plant and the Tundoo lead smelter on the up-stream side of river Damodar. Effluents from these plants add to the problem of water pollution in the coalfield. The Sindri Fertilizer Plant, Bihar State Superphosphate factory and the A.C.C. Cement Plant are, however, situated on the down stream side and their discharge into the Damodar river therefore does not aggravate the problem of water pollution in the coalfield.

Atmospheric Pollution in the JCF

Dust is generated in all stages of mining operations—starting from the winning of coal, during its transport in the mine, at the coal handling plant, and washery, and finally during despatch by truck or by railway wagon. Airborne dust causes pneumoconiosis or coal miner's lungs disease and a sample survey conducted in 1960 by the Chief Advisor of Factories, Govt. of India indicated an incidence of 18 per cent of pneumoconiosis amongst the coal miners of Jharia and Raniganj coalfield.

Leaving aside the dust hazard in underground workings, mining causes considerable dust pollution to the atmospheric air. The dust is raised mainly from the opencast sites, roads, railway sidings, tipplers, crushers, screening plants, coal preparation plants, coal stacks and coke ovens. The Colliery boilers, the steam locomotives working in the colliery sidings and the coke ovens and soft coke bhattas all add to the atmospheric pollution by the addition of smoke, grit and combustion products. Miners get free domestic coal and a lot of coal is used in domestic ovens by non-miners too. This is a significant source of air pollution in the Jharia coalfield. Smoke from a boiler is generally of two types, the initial brown smoke given as soon as raw coal is thrown into a grate and the dense black smoke given out by some boilers. The former contains a lot of unburnt volatiles and tarry matter. The dense black smoke which is continuously given out from many ill maintained boilers is due to the presence of carbon particles derived from the 'cracking' and subsequent quenching of hydrocarbon gases at a high temperature. In winter days the smoke and dust from soft coke Bhattas flow into the valleys and give rise to zones of dense smog so familiar in certain regions of Mugma and Jharia coalfields. Nasal discharge and burning of eyes are common in winter months in the coalfield.

On the surface, the production of airborne dust can be minimised by the judicious use of water and other binding agents. Water spraying of haul roads is a standard practice in opencast mines and is adopted for the binding of dust in roads leading to the siding and coal preparation plant in some of the collieries in Jharia field as well. Spray nozzles are fitted over tipplers, and conveyor belts crushers and in screening plants to provide at light blanket of mist over the coal. In some collieries steam is used in preference to water as it is a better dust suppresant. Sprays can be fitted on coal piles to prevent loss of fine coal by gusty winds. Spreaders based on the principles of a high speed belt thrower, as fitted in some of the sand bunkers in the aerial ropeway system in the Jharia coalfield, are particularly vulnerable to loss of fine particles by wind.

The burning of coal, whether in domestic ovens, boilers, coke ovens, brick fields or in mine fires, gives rise various air pollutants. The burning of sulphur in coal produces sulphur dioxide and other sulphurous gases causing damage to buildings, corrosion of metal parts as well as damage to vegetation. Tarry matter from smoke and dust settling on foliage interferes with the process of photosynthesis.

There have been very little study conducted on the problem of atmospheric pollution in Jharia coalfield. CMRS has conducted some studies on the pollution problem caused by the lead smelter located in the Jharia coalfield. The concentration of land fumes in the factory varied from 10 to 180 mg/m^3 and that of SO_2 from 7.7 to 142 ppm[5], which are higher than the usual TLVs for these fumes. Some studies on atmospheric pollution due to the cement plant, pyrite based sulphuric acid plant and nitric acid plant in the factory and in the general atmosphere outside the plant have also been carried out[6]. Some spot surveys were conducted on some evenings in November 1973 at important road junctions in the coalfield such as at Bhaga and Kirkend and a CO level of 3 ppm only was obtained. The frequency of motor vehicles was of the order of 4 per minute.

The pattern of atmospheric pollution in the Jharia coalfield may undergo some changes in the future. Transport of coal and sand by trucks have greatly increased during the last 5 years and pollution from diesel exhaust can become a major problem. This problem will aggravate as output of coal goes up and shortage of opencast production increases. Soft coke making process is likely to be improved as a number of R & D schemes have been proposed in the project Black Diamond in this regard. Some of the mine fires are also likely to be extinguished which would reduce the atmospheric pollution in the surrounding area.

Human Settlement

Mining in India has traditionally been a labour intensive industry and of all the coalfields in India, Jharia field has the

second highest level of employment. This is also a very compact field having the highest concentration of coal seams in the country. A number of ancillary industries have also developed in and around the coalfield. All these have made the coalfield a densely population region. BCCL has nearly 1,68,000 workers on its rolls. Taking the ancillary industries and service jobs into consideration, the coalfield may be considered to have a population of over a million.

In Jharia coalfield, environmental pollution due to human habitation has been intense. Septic tank latrines were not incorporated in most of the older labour quarters. Diseases transmitted by night-soil are widespread in the coalfield. There is hardly any organisation for garbage removal. Mounds of burnt ash and other domestic refuse litter the mining settlements. During summer, gusty winds raise dust from those garbage heaps and spread disease and illness. Water supply arrangement is also inadequate in the coalfield. Only after nationalisation of the coal industry, attention has been paid to this problem. Tube wells have not proved to be successful as a source of water. Because of the underground workings most of the tanks and wells in the coalfield become dry during the summer, specially in a year affected by draught. Jharia water Board supplies some 11.4 million litres of water per day, which is extremely inadequate for the need of the coalfield. Even for BCCL employees and their families numbering 6,45,000 heads, water requirement is 87.5 million liters based on a daily per capita water consumption of 135 liters, BCCL has therefore started implementing a large number of water supply schemes, based primarily on the mine water, for supplying to the mining settlements. The habit of defecating in the open and also sometimes in the underground workings had earlier created a feeling against the use of pit water for human consumption. However, construction of water treatment plants and building of pipe line system have changed the habits and attitude of the workers and the scheme has met with great success. Nearly 1120 million litres of water is pumped per day from the BCCL mines and as this water is generally fit for industrial and human use, this may prove to

be a valuable resource in the future. Another environmental problem is caused by dense human settlement in the coalfield. The coalfield has a barren and rocky terrain. The large human population has brought with it a large contingent of domestic animals which cause overgrazing. The already barren land becomes all the more bare from this cause. With the reconstruction programme of the Jharia coalfield, new satellite townships to cater to the needs of a cluster of mines will be built by BCCL in the fringe of the coalfield and such planned township will greatly help in improving the environment of the coalfield.

Concluding remarks

Present environmental problems of the Jharia coalfield has resulted from mining activities carried for nearly nine decades. With planned reconstruction of the coalfield, the output of coal would greatly increase from the coalfield. The mining techniques will also undergo major changes. This reconstruction plan also provides a unique opportunity to tackle some of the burning environmental problems of the coalfield, specially those due to fires and unplanned human settlements. There is a growing awareness of the need to protect and improve the environment and it is hoped that reclamation of mined out land will improve the environmental condition in the coalfield than what it is today.

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Irrigation and the Environment

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Introduction

THE RAPID industrialisation followed by urbanisation on one side, and the agricultural expansion coupled with technological innovation on the other, are not uncommon observations in many parts of our country. Since the implementation of Five Years Plans, the socio-economic structure of India began to show notable features. Development in different sectors have not only eased the country from the grip of nature's vagaries, but it also culminated in the creation of a new environment—the anthropogeneous living environment. Such environment began to carve distinctive imprints on the natural ecosystem and, consequently on the constituents of the eco-hydrological cycle, thereby creating complex environmental problems.

Awareness

Till recent decades, environmental quality consciousness had become a topic for pass time debate for arm-chair executives. Incidentally, the 1972 United Nation's Conference on Environment in Stockholm adopted the declaration on the human environment listing the principles for international efforts to protect the environment. Subsequent conferences under the auspices of United Nations and other non-govern-

mental organisations deliberated at length on several components of man's environment and the need for environmental education. Suddenly the subject ecology, environment and pollution became the burning questions for debate and discussions. The 1970 decade will certainly be recorded as the "decade of environment' in the history of mankind. The President, Mr. N. Sanjiva Reddy recently emphasised on environmental quality consciousness and urged Indian scientists to take into account the aspects of "conservation and preservation of the environment", while adopting the advances in science and technology to every day life in the society.

Planning for harmonious development recognises the trinity of man, nature and culture. Only a comprehensive appraisal of environmental issues, particularly socio-economic and ecological, facilitate such integration and check against the deterioration of the quality of life and environment. There are instances in which timely specialised advice on environmental aspects could have helped in proper designing of projects, and in averting subsequent adverse effects on the environment. It is, therefore, indespensable to introduce environmental aspects in planning and more so in perspective planning. Obviously, developmental projects—large or small —must be preceded by detail environmental impact analyses, and adequate weightage should be given to environmental risk and quality of life emerging over economic benefits. It is inspiring to know that the government is setting up a specialised machinary with adequate power to incorporate, in all planned development measures, the maintenance of ecological balance.

Irrigation

Agriculture, in the most part of India, is closely dependent on the vagaries of monsoon. It is the irrigation which forms the only life channel that stabilises agriculture and augments production especially in areas of scanty rainfall. In an irrigation system, the deliberate interception of stream flows is one of the age old methods of harnessing the water

resources in the country. To-day, such a method has reached a new dimension that encompasses extensively the river basins, and also has infiltrated both positive and grave environmental consequences within and around its fringes. At present, the irrigated area in the country is 45 million ha out of which three-fifths is surface irrigated and two-fifths is irrigated by wells. Irrigation by any standard may be divided into three groups, viz., major, medium and minor. In case of major irrigation projects, the environmental impacts resulting from their implementation, are generally taken into consideration at the planning stage and also the necessary precautionary measures are suggested. It is the medium and minor irrigation projects, which generally escape from the attention of planners and the project executing bodies. Though this is not done deliberately, it is normally so, owing to slow pace of environmental changes and small area coverage. However slow-paced the environmental changes might be, the impacts. especially the adverse ones in totality, tend to attain an unreparable proportions throughout the irrigation system. Therefore, the preplanned and consequent impact assessment studies are needed to be carried out to identify the appropriate measures and to arrest such negative impact subsequently.

Irrigation System

Any irrigation system comprises of three major functions. These are (a) collection of water, (b) distribution of water, and (c) utilisation of water. These aspects of water resources system interact with land resources including flora and fauna of the area. Among the three principle sources of irrigation namely river, wells and tanks, it is the irrigation system of a river basin which has relatively higher interaction and environmental dimensions. In an irrigation system, the river basin can be divided into following segments.

1. Catchment area
2. Dam, reservoir and its fringe area
3. Canal conveyance area

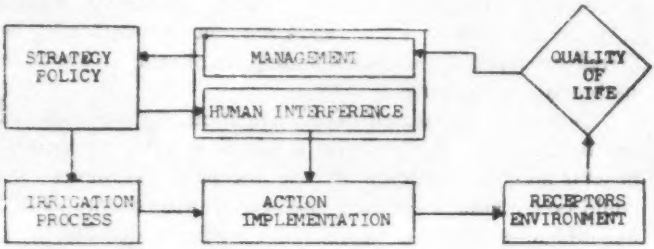
4. Command area, and
5. Downstream area

Although it is in the second and fourth segments where direct environmental changes occur, the conspicious changes taking place in the third and the remaining two segments cannot be overlooked in the processes of project implementation. The environmental impacts are both favourable and adverse on one hand, and spatial and temporal on the other. Man being the initiator of a new ecosystem, he not only enjoys the fruits but also at times suffers from his own creation. Therefore, a cumulative effect of the environmental changes brought by irrigation project implementation, is projected upon the human population and in the quality of life that he enjoys. Once an irrigation system starts functioning, a multitude of questions are posed before the decision makers as to; how do the inhabitants react and what have been their activities and attitudes towards the use of other natural resources of that area. It is not the existance of irrigation alone, but the different degree of interaction with other components of its system that determine the magnitude of environmental impacts.

Assessment Approach

The environmental assessment has never been an easy task. Before taking up the work for assessment, there has to be some set direction for analysis of the irrigation system. Normally, environmental assessment should be made either before or during the project planning and designing stages, and thereby take the futuristic view of the impacts. Furthermore, if adverse environmental impacts are not taken into consideration at its infancy stage of implementation and planning, the longterm cost of remedial measures due to such omissions could be greater than the short term benefits of the projects. Whenever results are associated with processes, their cause and effect relationship may be well understood. Irrigation (process), Action (implementation) and Receptors (concerned with quality of life) form the three principle elements; whose forms, functions and relationships both

within and without decide the magnitude of the impacts (See schematic diagram below).



Quality of Life

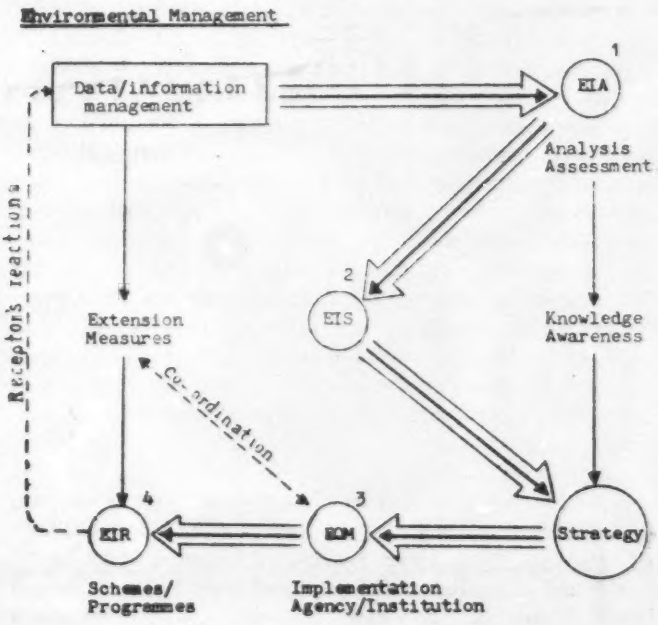
Quality of life is very much a subjective concept and also relative in character, as it is often scaled wtth level of satisfaction that the man can derive out of available material-prosperity. Therefore, any change in his life style is to be viewed very carefully and in compage manner. Irrigation is one among many major processes that bring change in nature ecosystem. In other words it contributes to the anthropogeneous living environment. Thus, many activities with their complex characteristics emerge on the scene, and their size, spread and intensity give shape to the environment that shields or erodes human life. The favourability of such resulted environment decides the quality of life. If the gap between' set aspirations' and' life being led; increases negatively then the disappointment follows; but if it reduces and becomes nil then the satisfaction abounds. The concept is obviously inclined towards material benefits, but this is inevitable as there is no known unit of measuring satisfaction.

Irrigation system is generally introduced with a sole aim of welbeing of all. The desired quality of life i.e. availability of nutritious food, clean shelter, sufficient clothing, good health and recreation, is the main aspiration for every human being. Therefore, activities initiated through irrigation should become means, and not the end.

The latent capacities of irrigation are thus, of far more importance to policy makers than merely exploitation of resources for temporary benefits. The assessment of physical environment along with socio-economic benefits will be, therefore, necessary in understanding the irrigation system in its broader perspective.

Normally, the success of any irrigation system is adjudged by examining the levels of production achieved, and the benefits acrued thereupon by the receptors. However, this could be criticised as biased method of assessment, as it is incomplete, unless the depreciation value added due to the environment-deterioration is also considered.

The model suggested hereunder, describes the stages involved in assessing the system. It also includes the feedback operation required to be followed at various stages of assessment and/or management of environment.



EIA - Environmental Impact Assessment
EIS - Environmental Impact Statement
EOM - Environmental Quality Management
EIR - Environmental Impact Remedies

Irrigation Impact

The impact of irrigation on environment and the magnitude there of, is controlled largely by the environmental status (ES) of the existing elements or factors which get directly associated with the various segments of the irrigation system. These factors are the geomorphology, hydrology and other natural resources characteristics of the irrigation system, the degree of human interferences and interactions in each of the segments, and lastly the dimensions of the system as a whole. Based upon some case studies, the environmental impacts, both positive and adverse, that are likely to occur in each segment of the irrigation system are summerised in the following paragraphs. The strategy suggested for their reformations is only indicative and not exaustive.

Catchment Area

Because of its position in the upstreams, the Catchment Area (CA) forms rather an impact contributor than impact receiver of the system. Cause and effect relationship being more effective in this segment, the assessment of its environmental status and the levels of human interactions become imperative in any impact studies, and prior to implementation of an irrigation project. It is the eco-hydrological imbalance in this segment that is liable to distort the whole irrigation system. The environmental status assessment of the CA should include the study of the geohydrology and geomorphology of the catchment area, the runoff and soil structure and also the density of flora and fauna of the area. The major adverse impacts due to human ignorance and illegetimate resource utilisation might lead to deforestation or loss of vegetation cover, increase in soil erosion, siltation of the reservoir and the formation of levees in the river bed.

About 1073 ha. of forest land has been cleared off in the process of increasing the command and rehabilitation in Panam Reservoir Project (Gujarat). Incidence of soil erosion is apparent in Panchana Project of Rajasthan. Formation of levees and delta type features due to excessive silt depositions

on the fringe of reservoir is conspicious in Jawai Bundh Project of Rajasthan. Afforestation and other soil conservation measures such as check dams and terraces on pediment slopes should be carried out in consonence with land management programmes.

Dam, Reservoir

Constructing dam on a river course for harnessing the river flow tends to submerge a vast trac. of land. Depending upon the coverage of the reservoir and slope of the surrounding area, the area under submergence may include fertile flood plain, dense forest cover, human settlements and even archaeological monuments. Although the principle of human compromise with natural resources and cost-benefit ratio is reviewed prior to the selection of the site for dam construction, the adverse consequences and potential hazards to inhabitants and ecological cycle of the area cannot be fixed out unless appropriate compensatory and rehabilitation measures are adopted systematically and simultaneously or prior to the project implementation.

Nearly 9,312 ha of land from 24 villages had gone under submergence of Shetrunji (Palitana) reservoir in Gujarat affecting the population of 19,000. The reservoir of proposed Bhimsagar Project in Rajasthan is likely to uproot 1,350 families of Answar Town. Morel reservoir (Rajasthan) has already a shallow basin and a considerable area under innundation. The proposal of increasing the height of this dam by 6 feet will invariably embrace larger acreage of cropped area around its vicinity.

In the Rabi season when the water recedes from the reservoir, the open bed may be carefully utilised for bed cultivation. Provisions of fillings and embankments to restrict reservoir expansion; similarly, rational rehabilitation measures of the uprooted families should be made so as to shield their earlier way of life, if not the improvement in quality of life.

Canal System

In its task of carrying water from the source to its

destination, the canal system invites adverse consequences which were formerly either unknown or completely ignored. The major environmental consequences are related directly to the conditions of its flow, spatial dimensions and the environmental status of the surroundings, The canal seepage might culminate in the rise of water table and creation of waterlogged areas along its vicinity, and also creation of water stagnant areas that provide ideal breeding places for mosquitoes and other insects. According to irrigation Commission (1972), about 14.4 and 10.9 lakh ha. of agricultural land respectively in Haryana and Punjab was affected by waterlogging. Problems of waterlogging range from moderate to servere, in Morel and Jaisamand Projects in Rajasthan especially along their canal systems. Lining of the canals forms the effective way of reducing the seepage losses and thereby arresting waterlogging problems in most of the projects. Besides adopting this as corrective measure, provisions should also be made to incise the canal depths and promoting of green belts along the canal fringes so as to reduce the loss of water through evaporation.

Command Area

Irrigation is always an attempt of increasing the agricultural efficiency of the area irrigated. However, due to either inefficient implementation of irrigation or mismanagement of the command area, the environment consequences, in course of time turn to adverse conditions, converting the former fertile land to wet desert and marshy lands. Such enviromental conditions tend to radiate unhygienic conditions for human settlements.

Inefficient irrigation management forms the basic factor of such adverse consequences. Secondly, the ignorance about the resources potentiality or capacity, also accelerate the problems of the command area. In south central Gujarat there are number of pockets which have had this bitter experience. The policy makers have suggested remedies to overcome such adverse effect of the environment by restricting the areas for perennial irrigation. Similarly the instructions were given to extension officers for educating the farmers in balanced

usage of agrochemicals and other innovative methods. The abandance of water and the scarcity of water, both lead to unhygienic situations at times, causing health hazards, Though the relationship between irrigation and the water-borne and water communicable diseases is not directly established, the incidence of diseases is never low in such areas.

Economic prosperity is the major positive impact in the command area resulting due to the development of an irrigation system. Development of irrigation in association with other factors influences the land use pattern in a positive direction in view of the necessity of increasing agricultural production. Irrigation development leads to change in cropping pattern with more inclination towards cash crops. Introduction and development of infrastructure facilities result in high agricultural production. All these things lead to the more employment generation, and thereby improves the quality of life.

Downstream Area

Because of the disturbances in the normal stream flow by the dam construction, the downstream area, especially downstream of the command area is bound to experience eco-hydrological changes and thereby becomes vulnerable to adverse environmental consequences. Decrease of channel discharge in the downstream areas is obvious in an irrigation system, but the slow-paced impacts arising out of such situation have to be anticipated beforehand and appropriate measures should be introduced to check their further deterioration. Depending upon the existing environmental status of the area, such adverse impacts include depletion of water table, increase in the lateral erosion of the river bed, reduction in the availability of surface water for use of human beings and animals, agrochemical pollution of underground water that flows out of the command area, change in landuse pattern and disruption of human settlements, industries and ports.

However, the adverse impacts that acrue in the downstream areas, its positive impacts owing to the project location at the upstream cannot be underestimated. This is more

so, if the area where the river flows happen to be susceptible to incessant floods. Here the dam and reservoir act as the flood moderator during the pick flows and thereby protect the downstream areas against periodical floods. The new medium irrigation projects that are to be located in the eastern plains of Rajasthan are likely to save Bharatpur and its adjoining areas from the periodical floods.

In order to maintain ecological balance in the downstream regions, attempts should be made first to study the geohydrological conditions of the whole irrigation system. Secondly, formation of proper irrigation management machinary: and lastly, the creation of alert volunteer agencies to help educating the receptors in making appropriate use of water resource, so aptly made available to the region.

Conclusions

It is necessary to carry out detailed investigations of environmental conditions and problems now encountered in the existing irrigation system and strict vigilance is must for forthcoming impacts, if any. Comprehensive planning and management of water resource systems are required with a view to do good to all and to increase the levels of quality of life, for years to come. Perfect coordination and harmony between various departments which are instrumental in triggering off actions within the system can play an important role in environmental planning. Organisational and institutional arrangements are to be made for implementation procedures and operational measures for combating the hazards developing because of man's interference in the ecosphere. Environmental research, diffusion of knowledge, training, public education, information and participation at all levels and times are some of the vital activities in environmental planning. It is also essential to make sufficient provisions for legal, compensatory and subsidy measures called for, in the system to protect the interests of the affected individuals, communities and the local Governments. The conservation of natural resources, including human resources should not be

lost sight of while initiating the irrigation system at macro, meso or micro levels.

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10

The Silent Valley Hydroelectric Project—A draft Environmental Impact Assessment

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The porposed Silent Valley Hydro Electric Project

LOCATED IN THE northern part of Kerala, the Silent Valley Hydro Electric Project (SVHEP) as planned by the Kerala State Electricity Board (KSEB), contemplates harnessing the waters of Kunthipuzha, for generation of power.

The project envisages construction of a 131 m high concrete arch dam across Kunthipuzha about 40 km upstream of Mannarghat and diversion of the impounded waters through a power tunnel 4526.28 m long and two surface penstock pipes each 2335 m long to a powerhouse located at the toe of hills about 8 km from Mannarghat, to generate 60 MW firm power at 100% LF corresponding to 522 mu, of energy per annum.

The original project estimate for Rs. 2488 lakhs was sanctioned by the Planning Commission in 1973. Since then slight changes in the features of the component structures have been brought about. The height of the dam is raised by 8.69 m increasing the storage from 251,74 to 317 m cum. The type of dam is changed from masonry gravity to concrete arch. The installed plant capacity is increased from 3x40 MW

to 4x60 MW. The above change ensures better utilisation, ease of construction and general economy.

The project as now conceived is estimated to cost Rs. 4880 lakhs (1978) for completing the first stage with two units of 60 MW each, the water conducton system and the power house structure having been designed for the ultimate stage to accomodate all the four units. A six year construction schedule is envisaged for the execution. It is proposed to commission the first unit in March 1984 and the second unit in another six months.

The reservoir when filled up will submerge an area of 830 ha. Of this 330 ha are devoid of trees and do not involve any forest clearence. The extent of land required for colony, roads etc. is insignificant. Certain suggestions have been given by the sub-committee appointed by the Task Force for the Ecological Planning of the Western Ghats to preserve the ecological richness of the area. The KSEB has agreed to adopt measures for preserving the ecological balance of the area as far as practicable. The water released from the power house will be further utilised for irrigating about 10000 ha of land lower down the valley.

Justification for the Project

At the commencement of the first five year plan, the firm energy generating capacity of the state was 151 Mu. This was raised to 466, 769. 1024 aud 2715 Mu at the end of the 1st, 2nd, 3rd and 4th Five Year Plans respectively, against which the actual generation was 350, 581, 842 and 2513 Mu. The KSEB has since drawn up a realistic estimate of the annual energy requirement and peak demand in connection with the 10th Power Load Survey. The peak demand in the southern region is expected to increase to 7939 MW by 1983-84 and the corresponding energy reguirement is estimated at 44302 Mu. The peak demand and energy requirement in Kerala at that time are estimated to be 1285 MW and 6753.5 Mu. respectively. There are at present 9 hydroelectric stations with a total installed capacity of 1011.5 MW. These stations to-

gether generated 3164 Mu during 1966-67, the combined maximum demand on them being 661.5 MW. The only generating station in the northern part of the state is Kuttiadi.

By 1984-85 the total installed capacity of the state grid will be 1256.5 MW and the annual energy generation capacity will be 6323 Mu. The demand for power exceeds the above figures. Being located in the northern part of the state the project when completed would stabilise the voltage position in the region besides meeting the deficits in the demand and supplying a large block of peaking power to the system. Early completion of the project is vital to the backward areas of Malabar where developments are lagging behind.

Environmental consepuences that are likely to arise from the above mentioned developmental Plan

Silent Valley falls within the general classification 'Tropical wet evergreen forests' and more specifically under the heading 'Southern tropical wet evergreen forests' which is floristically and faunistically different from similar forests found in some parts of our north-eastern states. Tropical wet evergreen forests are undoubtedly one of the most valuable, most threatened and scientifically least studied of the earth's habitats. Highly favourable soil and climatic factors and their relative stability of over many millions of years is responsible for the development of such areas, each hactare of which usually contains thousands of different special. The plants and animals provide the largest pool of genetic resources for new discoveries in the field of food crops, medicines, pest control and for other vital contributions to solving human problems. As a result of their great diversity there is a very small population of any one species in a given area and a high degree of specialisation and specific adaptations, which make these species particularly vulnerable to human interference. It is ofcourse impossible for any human efforts to recreate such a complex ecosystem, even in the most approximate manner once it is destroyed.

In the specific context of Silent Valley, says Dr. Salim

Ali, it is one of the most valuable natural areas left in our country. Forests of this type which form a very small proportion of our total forest area to begin with, have now been completely destroyed, or reduced to small and fragmented is lands which cannot hope to survive the human pressures to which they are being subjected. Thus although there may be small pockets of Southern tropical wet evergreen forests still left in the Western Ghats, which are equally rich in life forms, Silent Valley is particulary important in being an intrinsic part of one of the largest contiguos belts of relatively undisturbed West Coast tropical evergreen forests left in the country.

From the floristic point of view, Silent Valley is a very precious heritage not to be tampered with and if preserved as a Bioreserve can be profitably used as a refernce to a composite wet evergreen forest by posterity and if disturbed shall have disasterous effect on the process of evolution, particularly genetic selection (Nair 1980). Silent Valley is rich in orchids. There are several economically important trees fruit plants, and medicinal plants. Wild *Eletaria cardamomum, Piper nigrum, Zingiber* sp. etc. are common. Wild relatives of cultivated plants are many. Silent Valley is also rich in ferns. The preliminary study revealed that there are several species not included in Gamble's 'Flora of the Presidency of Madras'. Some of them are: *Apyllorchis prainii, Burmannia championii, Eulophia emilliana, Oberonia brachyphilla, Ressantia grahamii,* and *Smithsonia straminea. Vajravelu* 59109 *(Hedyotis)*, N.C. Nair and Vajravelu 64275 *(Eulophia)* and N.C. Nair 56668 *(Thelypteridaceae)* are probably new to science. New varieties of *Tectaria parodoxa, Pteris longipes* and *Diplazium latifolium* have been located in the valley. *Pteris dactylina* early known from N.E. India and China has also been collected. No specimen of *Salacia reticulata* is represented in the Madras Herbarium (MH), but it has been collected from Silent Valley. Some of the other flowering plants which were known from other parts of India but now found only in the area include *Antistrophe serratifolia, Holigarna nigra, Lasianthus jackianus, Stylocoryne nilagrica, Ventilago bombaensis, Zanonia indica* etc. There are several rare endangered species in the valley including *Toxocarpus*

palghtansis, *Cryptocarya wightiana*. *Didymoplexus pallens*, *Hopea utilis*, *Poeciloneuron indicum*, etc. Ferns reported by Beddome from S. India and not represented by any specimen in MH other than the collections from Silent Valley include *Macrothelypteris ornata*, *Pteris geminata*, and *Pteris longipes*.

Silent Valley is better known to zoologists as the major habitat of two species of endangered mamals, the lion-tailed macaque and the Nilgiri tahr. Many other mammals are also known in the forest. The avifauna is egaally rich, with more than a hundred species of birds being known.

A faunistic survey recently carried out by the Southern Regional Station of the Zoological Survey of India, has collectd valuable informationson the fauna not hitherto available. The insect collections are rich and varied consisting of many rare species, new records and new categories. A new genus of Homalopterid fish which has close affinities with the genus *Pseudohomoloptera*, a native of Borneo, has been discovered here. There are more examples of Cobitidae which might prove new to science. About 20 species of Amphibia have been identified, which include atleast two new species. Many species and genera endemic to Western Ghats have been obtained. A good population of endangered group of Apodans (Caecilians) has been discovered to exist there. Among reptiles, three species of lizards show distinct variations from their allies elsewhere, atleast one of them being new to science. All these animals are likely to be affected if a portion of the forest is destroyed by submersion.

Altogether the project requires 1022 ha. of land of which 950 ha are evergreen forests. The total number of trees that will be lost to the area is not assessed yet except for the portion of the submergible area. According to an enumeration of the trees conducted in this portion *Pelaquium ellipticum* and *Cullenia excelsa* are the two species which would be destroyed in large numbers. The most complex floristic components are concentrated on the river banks and this will be lost for ever by submersion.

The effects on wildlife can be best illustrated by a case study with respect to one of the major species viz. the liontailed macaque. Its population was estimated at 1000 in 1961-63 in its range between 9°30N and 10°30N. But in 1975 its population was estimated at about 500 after surveying a still larger area. Thus there is clear evidence that the population has come down to half in about twelve years. According to recent studies, it has been estimated that each troop of this animal requires a minimum of 5 sq km area of continuos forest of the tropical wet evergreen type and that a viable breeding population will require about 130 sq km of unbroken forest with a minimum of 33 troops. It the Silent Valley population disappears then the only viable populations left is in the Ashambu hills. This population could run a serious risk of extirction through, say an epidemic. If we have atleast two such populations then if one of them suffers an epidemic it could be repopulated from the other area. If there is one such population left we run a much graver risk of extinction of the species. It is also to be noted that fragmentation of the habitat of a species or a community has tremendous implications which were not understood earlier. The maintainance of the integrity of the biological community is therefore now understood to be very vital to its preservation. The Silent Valley lies at a critical point in this context between the Attapadi and the New Amarambalam Reserve forests. Hence a break in the continuity of this biological community will have implications for more serious than the loss of a small proportions if its area. The proposed hydroelectric dam would inevitably destroy the most suitable habitat of the liontailed macaque in the Silent Valley.

Preservation of Silent Valley has bearing on the ecological functions of the Western Ghats with regard to the climate and rainfall of most parts of our couutry. The Western Ghats which rise to more than thousand metres above sea level and stand facing the Arabian sea receive the full blast of the South-West monsoon, a rain fall of upto 500-600 cms within a short span of three to four months. The eastern side in contrast, receives only 40 cms of rain.

Only if the natural cycle of precipitation, percolation evaporation and transpiration are kept undisturbed and the rain water which descends to the ground conserved either underground or in rivers, streams and reservoirs, we will get the most from the rain bearing clouds which cross the plain of the state and get arrested by Western Ghats. This is possible only if the nature of the soil, and its vegetation cover, humidity and temperature are not altered drastically from their present patterns. The Task Force constituted by the NCEPC had stated that if the present trees are replaced by others for silvicultural or horticultural purposes, or are removed for any other reason, the topsoil will be washed away in a single monsoon following its denudation and that the land will thereafter become unfit for productive exploitation perhaps for ever. The fact that such havoc has already happened in one of plateaus of the Western Ghats, viz. Idukki, is sure proof of what is in store for the Silent Valley.

Interaction problems

Environmental impacts manifest themselves on plant, animal and human life and the ecosystem as a whole through several interconnected and complex interaction mechanisms.

In the Silent Valley, the free flowing river has a natural shore-line vegetation which provides habitat for many wildlife species. When the area is submerged, the impounded shore-line cannot have the same vegetation as the natural shore-line vegetation. Frequent fluctuations in the reservoir level will reduce the chances of re-establishment of a natural formation. The ecological effects of water impoundment may be summerised as follows:

1. Inundation, and in effect, disappearance of certain amount of biomass represented by the vegetation originally existent,

2. Disruption, as a consequence of (1), of life systems supported by the biomass, causing migration on extinction of micro-life,

3. Localised climatic changes,

4. Blockade of anadromous fish migrations and elimination of important fish runs,

5. Introduction of an artificial factor for genetic selection,

6. Destruction of spawning grounds of important edible fish species, and

7. Prevention of rapid water movement resulting in silt trapping and greater water stability with growth of heavy aquatic weeds where none grew before.

Shore-line vegetation offers nesting sites for various species of birds. Various species of birds of prey, Civet and smaller Cats visit this area regularly. Inundation of this vegetation along with the boulders would be followed by a chain of reactions on other related species. For example, disappearance of birds of prey from an area would result in a population explosion of rodents. These rodents in a natural forest feed on eggs, on birds and at times on nestlings, on fallen fruits and seeds as well. Therefore a sudden outburst of their population might effect the destruction of at least a few bird species and also the natural propagation of vegetation. This will affect the herbivores and in trun the carnivores. Inundation may not affect all the wildlife, but it will affect all those species which are completely dependent on the riperian habitat and which are habitat specific. These considerations are applicable to the Kunthipuzha which will face the fate of impoundment.

The impact of human influx is also worthy of consideration. During the peak period of construction about 3000 persons will be employed on the average. A labour force of this size together with their dependents would form a population around 6000 to 8000. They will have to be settled in the forest land. Considering the experience of previous projects, we may foresee the definite possibility of serious

damages to surrounding areas by fuel extraction etc. Poaching and trapping of animals would become a regular practice. Even if special precautionary measures are taken, there would be no effective control over such misdeeds. In the light of experience, we may anticipate the unabated continunance of encroachments, poaching and shooting of animals even when the Wildlife Act, the Forest Act and such other legal measures are under enforcement.

Threat to Village Crops

There has already been complaints that the crops in the villages around the forests are being raided by wild animals. Wild boar and Porcupine are the most menacing among them. Cattle-lifting by tiger has also been reported. Further pressure on and persecution of wildlife by the inhabitants in the centre of the forests would force them out into the fringes of the forests, ultimately becoming a real threat to crops. The elephant raids in the Mukkali colony are attributed to the construction activities in the silent Valley.

Recommendations

The Selent Valley Hydel Project is neither essential nor unavoidable. The alternative pathways available immediately for providing power, irrigation and jobs at no ecological risks will help to achieve the desired social goals more speedily and economically (Swaminathan 1979). As has been explained in the refutationa by Task Force members, no safeguards can possibly protect the ecological balance of the Silent Valley ecosystem.

There is no question that Kerala will need to continue to tap its hydel potential for the benefit of its people. It would be unreasonable to expect that work on all hydel projects must stop until a comprehensive compartive study is done. But it is important that projects are first implemented in areas which are ecologically less valuable than in those which are *prima facea* more valuable. Today options for alternative dam sites are still available in Kerala. Completion

of the ongoing schemes will provide enough power for Kerala's near future demands and for selling to neighbouring states. The legitimate demands of the local people for additional labour, irrigation and electricity can be met by implementing the proposals of Dr. M.S. Swaminathan immediately.

In his view the following steps will be advisable in order to achieve harmony between the needs of today and tomorrow and to promote the desired degree of development without the destruction of biological wealth of inestimable value.

1. The entire area of 39,000 ha consisting of (a) Silent Valley forest, (b) New Amarambalam reserve forest, (c) Kundas forests, and (d) Attapadi reserve forests, should be developed into a National Rain Forest Biosphere Preserve. The cost of developing a National Rain Forest Biosphere Preserve may be borne by the Govt. of India, since the preservation of this unique forest area will be to the benefit of both Kerala and the entire nation. The Silent Valley Environmental Monitoring Committee already constituted by the State Govt. could become the National Rain Forest Biosphere Preserve Planning and implementation Committee and start the work immediately under the overall guidance of NCEPC. It developed along proper lines, the Silent Valley Rain Forest Biosphere Preserve can become a sanctuary for valuable genes in several medicinal and plantation crops, such as pepper and cardamom. This whole region has also been found to be a reservoir of useful genes in rice conferringresistance to some major pests. Therefore urgent stepds should be taken to prevent the erosion of valuable genes from this area.

2. The Kerala Forest Research Institute at Peechi may be developed into an international research and training centre for the study of tropical rainforest

ecosystems. This will be appropriate in view of the widespread interest, particularly in countries in South-East Asia in tropical evergreen rainforest flora and fauna.

3. A detailed ground water survey of the Palghat and Malapuram districts should be completed soon and steps should be taken to provide irrigation through the available ground and surface water resources in as much area as possible... The potential for irrigation for mobilising the available ground water sources seems to be very good. For implementing the irrigation project a Palghat and Malapuram Irrigation Project Committee may be constituted immediately, jointly by the Central and State Governments.

4. The immediate electricity needs of the Palghat and Malapuram area could be met by developing suitable transmission lines from the Idukki Project area. The transmission schemes for Kerala costing about Rs. 45 crores have been provided in the Sixth Plan. Also, Idukki stage 2 of 3x 130 MW at a cost of 15.5 crores has already been approved by the Planning Commission. A long term energy profile and strategy may be prepared by a group of national experts with the help of the KSEB, taking into account potential developments in the utilisation of solar energy.

5. Steps should be taken to promote suitable industries in the area so that additional opportunities for generation of employment can be created. A Palghat Malapuram Employment Generation Consortium may be set up for preparing employment and income generation programmes based on resource utilisation strategies.

6. The amount of Rs. 200 lakhs provided for SVHEP in the State budget for 1980-81 could be utilised for groundwater development, establishment of transmission lines from Idukki and for suitable industrial

and agricultural projects. An adequate allocation should be made in the Plan Budget during the Sixth Plan period for the rapid eco-development of the Palghat-Malapuram region. Preferably, the entire allocation for SVHEP should be reserved for this purpose.

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11

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